This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

SD
12
C6
no.8

Forestry Library

UC-NRLF
$B 6 580

FC
2
UNIV

SD12
C6
no.8
Forestry
p.b.

State of Connecticut

REPORT

OF

The Connecticut Agricultural Experiment Station

NEW HAVEN, CONN.

CONCLUSION

SIXTH REPORT OF THE STATE FORESTER

WALTER O. FILLEY

BEING PART VI OF THE ANNUAL REPORT FOR 1912

FORESTRY PUBLICATION NO. 8

Lib

SIXTH REPORT

OF THE

STATE FORESTER

OF

CONNECTICUT

Agric Exper. Sta.

FOR THE YEAR 1912

BY

WALTER O. FILLEY

State Forester

New Haven, Conn.
1913

FORESTRY

CONTENTS.

Introduction.. 455
Forest Fires.. 457
State Forests.. 462
Station Forester.. 466

Rainbow Forest Plantations:

Description of Experimental Plots........................ 471
List of Experimental Plots........................ 481
List of Species on Experimental Plots........................ 482

Forest Planting in Connecticut:

Progress of Forest Planting........................ 485
Information Regarding Forest Planting........................ 488

SD12
C6
no. 8
FORESTRY
LIBRARY

PART VI.

REPORT OF THE STATE FORESTER

WALTER O. FILLEY.

INTRODUCTION.

The Forester of the Connecticut Agricultural Experiment Station is *ex-officio* State Forester and State Forest Fire Warden. The work of the Department of Forestry may accordingly be classed under three heads.

The Station Forester works along the following lines:

1. Investigation of forest conditions, and the problems involved in the profitable management of Connecticut woodlands. This is carried out on both State and private lands.

2. Experimental work in forest planting and management. As such experiments must be carried on for a term of years to secure results of value, most of this work is on land belonging to the Station or to the State, although occasionally experiments are undertaken in coöperation with private land owners.

3. Dissemination of information regarding forestry. In accordance with the established policy of the Experiment Station, the Forestry Department aims to help woodland owners and the public in general to obtain a knowledge of forestry principles and methods. To accomplish this object, practical assistance is given to all applicants so far as possible, either by correspondence, or preferably by means of examination of land and recommendation as to treatment; news articles are prepared for the press, and publications are issued from time to time giving the results of investigations and experiments with the practical application of the lessons learned; public addresses and illustrated lectures are given before farmers' institutes, granges, and other organizations which may be interested.

M710104

The State Forester has charge of the State Forests already established, and is authorized to establish others as funds may be made available for the purpose. It is his duty to protect and to develop these State Forests by planting, and by improvement cuttings, the receipts from such cuttings being used for further improvement work.

The State Forest Fire Warden is the head of a fire warden service which includes a town fire warden in each town, and such district or deputy wardens as conditions in each town may render necessary. The forest fires extinguished by local wardens are reported by them to the State Warden accompanied by bills for services rendered or expenses incurred. Such bills, after examination as to legality, are recorded and referred back to the towns for payment on approval by the selectmen. From a study of the fire reports, facts are determined as to the causes of fires, and the best methods of preventing and extinguishing them. As the State Forest Fire Warden is responsible for the efficiency of the service and enforcement of the laws regarding forest fires, it is incumbent on him to issue such instructions and supplies as will bring about the desired results. Press bulletins and other material of an educational nature are also issued from time to time.

These various branches of the regular work of the Department are taken up in detail on the following pages, the order of their discussion being reversed for convenience in arrangement. During 1912, the forester was involved in a special line of work which is not fully covered in this report. He was *ex-officio* a member of a Special Commission on the Taxation of Woodland, authorized by the General Assembly of 1911. As secretary of this Commission he found it necessary to give considerable time to the gathering of material and preparation of a report. This report is to be presented to the General Assembly of 1913 and will form the basis for legislation on the subject of forest taxation. Copies may be obtained from the State Forester or the State Tax Commissioner.

The proposed legislation will provide a just system of taxation for all forest land in the State, but will be optional in its application. Opportunity will be offered for the classification of forest land as such, a fair valuation of the land for purposes of taxation to be established and maintained without change for a definite period of years. An annual tax on this valuation of the land alone will be provided for in addition to a yield tax on the timber when cut. Such a law will be an encouragement to investors in forest lands, for it will make it possible to determine definitely the amount of taxes chargeable against such an investment in future years. This will remove one of the factors which has interfered with the progress of forestry work in this State, since uncertainty regarding taxation is a heavy handicap to a long time investment.

The first Station Forester, appointed April 1, 1901, was Walter Mulford, F.E., Cornell. He was appointed State Forester, July 1, 1901. On July 1, 1904, he was succeeded by Austin F. Hawes, M.F., Yale. By act of the General Assembly he also became State Forest Fire Warden in July 1905. He resigned April 1, 1909, and Samuel N. Spring, M.F., Yale, was appointed State Forester on October 1, 1909. Having served for two years as Assistant in Forestry, the writer was appointed Assistant State Forester, October 1, 1911, in accordance with an act of the General Assembly providing for such an office. Mr. Spring resigned October 1, 1912, and the writer was appointed his successor. Mr. A. E. Moss, M.F., Yale, was appointed as Assistant in Forestry from that date.

This report for 1912 is intended to sum up the work of the Forestry Department in all lines since its establishment. The policy of the present Forester will be in accordance with that of his predecessors, but he will have the advantage of building on the foundations they have laid and should therefore be able to show a distinct advance in the forestry work of the State during the next few years.

FOREST FIRES.

The report of the Forester for 1910 was largely devoted to this subject, and discussed fully the results of the Fire Warden work for the years 1905-1910. Especial attention was given to the figures for 1910, because the conditions in that year were such that a large number of fires (834) occurred, and it seemed probable that this would prove to be a maximum record which would not be equalled in succeeding years.

TABLE I.—NUMBER OF FOREST FIRES BY MONTHS.

Year.	Total Number.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1910.......	834	0	0	285	305	45	2	9	0	6	141	41	0
1911.......	978	5	0	66	425	390	13	20	25	1	10	21	2
1912.......	526	1	3	27	109	90	34	53	5	3	142	38	21

By reference to Table I, it will be seen that this expectation was unfulfilled. The conditions in 1911 were worse than in 1910, especially during the months of April and May, when 815 fires occurred. Although the warden service was more efficient and more vigilant than ever before, a total of 978 fires was reported with damage, cost, etc. as given in Table II.

TABLE II.—SUMMARY OF FOREST FIRES, 1911.

County.	Total number.	Causes.							Acres burned.	Estimated damage to standing timber.	Estimated damage to forest products and buildings.	Cost of fighting.	Cost of protection.
		Unknown.	Railroad.	Careless.	Burning Brush.	Incendiary.	Fireworks.	Lightning					
Fairfield......	147	69	38	18	20	2	..	..	5,376	$11,585.50	$ 637.00	$1,684.35	$201.13
Hartford	207	90	69	25	19	4	..	..	13,550	67,982.00	13,420.00	3,784.54	309.37
Litchfield.....	162	49	69	18	22	4	..	..	14,604	41,302.00	3,444.50	2,616.29	111.94
Middlesex ...	69	24	29	6	9	1	..	..	6,128	26,389.00	1,449.00	714.63	36.48
New Haven..	143	69	40	18	16	..	..	..	7,073	30,008.00	2,492.00	1,693.04	29.43
New London.	73	52	6	8	6	1	..	..	8,074	20,660.00	1,105.00	1,079.76	17.41
Tolland......	78	27	26	14	11	..	..	..	4,697	25,613.50	16,427.00	1,605.50	14.66
Windham.....	99	36	42	10	5	5	..	1	5,496	30,475.00	2,610.50	1,803.39	45.52
Totals	978	416	319	117	108	17	..	1	64,998	$254,015.00	$41,585.00	$14,981.50	$765.94

Conditions in 1912 were very much better, particularly during the spring, when most fires occur in a normal season. Rains during the previous fall and abundant snows during the winter had matted down the leaves, and the rainfall during the first five months was more than six inches in excess of the normal. Consequently very few fires occurred and few of those reported caused large damage. After June first, conditions changed greatly and but one half inch of rain fell during the month. The precipitation was considerably below normal in each succeeding month until December. During the summer and early fall, fires were frequent and exceedingly difficult to put out owing to the dryness of the soil. Many fires burned underground for a week or more, covering only a few acres in each case, but requiring constant watching to prevent their getting beyond control.

Table III gives the complete record for 1912. In comparison with previous years it shows a less number of fires (526) than 1910 and 1911, and less area burned over than in those two years, as well as in 1908, when the number of fires reported was but little over one-half as large. (See Table IV.) The cost of fighting also shows a considerable decrease over the two previous years both in gross and per fire. This cost would have been much smaller had it not been for a few summer fires which burned for several days. Although weather conditions must be given much credit for the good record of 1912, the activity and efficiency of the wardens should not be underestimated. Their vigilance prevented many small fires from becoming serious. On the whole, there is plenty of evidence that the fire warden service is more active and efficient each year, and it is evident that with a few exceptions, the towns of the State are realizing the necessity for extinguishing fires promptly.

TABLE III.—SUMMARY OF FOREST FIRES, 1912.

County.	Total Number.	Causes.							Acres burned.	Estimated damage to standing timber.	Estimated damage to forest products and buildings.	Cost of fighting.	Cost of protection.
		Unknown.	Railroad.	Careless.	Burning brush.	Incendiary.	Fireworks.	Lightning.					
Fairfield	44	17	20	5	1	1	...	...	832	$ 1,786.00	$ 107.00	$ 143.28	$204.49
Hartford....	129	44	44	26	9	2	1	3	5,088	21,572.00	5,377.24	2,011.20	151.53
Litchfield ..	87	28	35	13	7	...	3	1	2,344	6,286.00	396.00	1,142.88	182.81
Middlesex..	41	18	14	7	2	...	...	...	1,924	6,617.00	50.00	261.20	96.32
New Haven.	82	39	10	22	2	5	3	1	868	2,878.00	681.00	653.38	78.93
New London	35	13	3	18	1	...	...	...	1,878	7,565.00	51.00	468.91	36.64
Tolland.....	43	12	16	13	2	...	...	...	738	2,494.00	4,377.50	486.99	21.84
Windham ...	65	22	31	7	2	3	...	...	1,943	6,834.00	145.00	499.80	21.87
Totals ..	526	193	173	111	26	11	7	5	15,615	$56,032.00	$11,184.74	$5,667.64	$794.43

Prompt action by wardens means smaller damage as well as less expense to the towns and State. Wardens, however, cannot be expected to neglect their other business to watch for fires, no matter how public-spirited they may be. It is therefore very desirable that assistance in locating fires be rendered the wardens in every way possible. For this purpose, the U. S. Post Office Department has instructed rural mail carriers to report to the nearest warden as soon as possible, any fires they may see in covering their routes. This should prove of great assistance in Connecticut, as most of the forested area is covered by carriers once each day.

TABLE IV.—SUMMARY OF FOREST FIRES, 1905–1912.

Year.	Number of wardens.	*Number of towns not reporting.	Number of fires reported.	Area burned. (Acres.)	Average area per fire. (Acres.)	Cost of fighting.	Average cost per fire.
1905	44	126	...	†8,000	....	....	.....
1906	119	94	125	4,036	32.3	....	.....
1907	140	76	109	4,387	40.2	$1,286.46	$11.80
1908	152	64	283	18,430	65.1	3,646.66	12.88
1909	157	18	339	14,779	43.6	2,755.46	8.13
1910	160	19	834	47,443	56.9	10,024.76	12.02
1911	163	9	978	64,998	66.5	14,981.50	15.32
1912	168	28	526	15,615	29.7	5,667.64	10.77

* Includes nine principal cities whose limits are coterminous with those of the town.

† Estimated at the end of the year.

It also seems desirable to establish lookout stations on a few high points in the State from which observers may watch for smoke of forest fires during the danger seasons. If the stations are equipped with telephones, the observers will be able to locate fires definitely and inform the nearest wardens at once. Two stations were maintained experimentally during 1912 with valuable results, even though the favorable season made their value less apparent than it would have been the previous year. If possible, other stations will be established during 1913, the State coöperating with towns and land owners when practicable.

Under the so-called Weeks Law, which provided for National Forests in the White Mountain and Appalachian regions, the Federal Congress authorized the U. S. Forest Service to coöperate with the various states in protecting from fire the forested watersheds of navigable streams. Federal funds were thus made available for use in paying for the services of observers at lookout stations in northern Connecticut. This arrangement will be continued in 1913.

Past years have shown that a large proportion of the fires in this State are due to sparks from railroad engines. During the spring of 1912, when fires were few on account of plentiful rains, forty-one per cent. of the fires reported by wardens were attributed to this cause. In 1911, when fires from all causes were more frequent, only thirty-five per cent. were reported as railroad fires. Believing the value of patrols should be demonstrated with a view to securing future coöperation with the railroad companies in such work, ten patrols were maintained during the danger season along stretches of track where fires are of common occurrence. These patrols were paid by the Federal government under the coöperative arrangements mentioned above. They reported extinguishing 270 small fires during the year. These were in addition to the number reported by wardens (172), and many of them would probably have become serious had they not received such prompt attention. With the figures thus obtained as a basis, plans for patrol work will be submitted to the railroad companies, with the expectation that they will do such work where needed in 1913.

Chapter 114, Public Acts of 1911 provided that all bills for extinguishing fires due to railroad causes should be paid by the company responsible. Under this law, bills amounting to over $600 were paid during 1912. Had the law been in effect in the spring of 1911, the fire bills to railroad companies would have undoubtedly shown a larger total, and the cost of fire fighting to the towns and State would have been correspondingly reduced. If the money spent in this way and in settling damage claims were used in patrol work and other preventive measures, the resources of the community would suffer less damage from fire.

In the future more attention must be given to measures of prevention calculated to eliminate, so far as possible, the more easily determined causes of forest fires. The railroad fire problem is the most obvious, and its solution should be easy provided the railroad companies will coöperate with the State. Other causes must be eliminated largely by educational measures which will arouse the general public to a sense of its responsibility regarding forest fires. Enforcement of the laws providing penalties for carelessness with fire will help greatly by furnishing a few object lessons. Much can also be done in the public schools and through the press to emphasize the need for care in handling matches, cigars, etc. when in the woods. To emphasize the need of such work, the following analysis is given of 137 fires reported during 1912 as due to carelessness on the part of individuals:

Auto party	1	Matches	5
Burning brush	26	Smokers	25
Children	6	Strollers	2
Fishermen	4	Not given	21
Hunters	47		

It is evident that most of these fires were due to carelessness in handling matches, throwing down cigar butts, etc., or leaving fires unextinguished. It also seems reasonable to believe that very few of the people responsible for such fires would have intentionally set them, since their presence in the woodland would indicate that they enjoyed the natural conditions found there. Hence the belief that the public can be educated to the need for greater care to preserve such conditions from destruction by fire.

STATE FORESTS.

With the appointment of a State Forester in 1901, Connecticut adopted the policy of acquiring land for State Forests. The value of land which might be purchased was limited by law to four dollars per acre, and no specific appropriation was made for the purpose until 1909. From the biennial appropriations of $2,000 each which were provided to cover the expenses of the State Forester, including travelling, taxes, protection, planting and other expenses incident to the administration of the State Forests, a total of 1,512 acres of land was purchased previous to 1909 at an average price of $2.10 per acre. This increasing area caused greater expense of administration with consequent reduction in amount available for purchase. Increasing difficulty was also met with in securing desirable lands at prices within the specified limit of four dollars per acre.

The General Assembly of 1909, therefore, made an appropriation of $5,000, to be available until expended, for the purchase of land suitable for State Forests, and in 1911 the maximum purchase price of such land was increased to eight dollars per acre. This limit gives a better opportunity to secure desirable tracts of land which would otherwise be unavailable on account of price. In most cases the cheaper lands are located so far from the railroad that it is not only difficult to market the timber products but they are not sufficiently accessible to visitors to render them of the greatest value as State Forests.

The purpose of such forests in this State is two-fold. First, they should be demonstration areas where the application of forestry principles to local conditions may be shown to woodland owners and experiments in afforestation and management may be carried on for a long period. Second, they should be reserves for the growth of large timber, since the State is much better able than private owners to carry such long term investments. Thus they may be considered a source of future profit to the State, as well as a source of future supply of large timber for local uses.

Since conditions vary considerably in different parts of the State, it is desirable that the demonstration areas be located in different regions so as to include these various conditions. The location of a State Forest in each county would assure this result. It has therefore seemed best to acquire contiguous areas which could be thrown together and managed as one large tract in each county, rather than a number of widely separated small tracts which could not be combined to advantage. Two thousand acres of woodland can be more economically managed than five hundred or one thousand acres. So far, however, it has not been practicable to acquire a tract of two thousand acres in one piece, although this has been the aim of each State Forester.

The Portland State Forest, in the towns of Portland and Chatham, now contains approximately 1,100 acres of land, bought at an average price of $1.90 per acre. Most of this land had timber growth of some sort, and much of this was of sufficient size to permit improvement cuttings or thinnings. The products of such thinnings were disposed of to the best advantage as railroad ties, posts, or cordwood. On account of the distance from market, no profit has been made on the cordwood from thinnings and the best returns have been obtained by selling it to local charcoal burners. Approximately 125 acres have thus been thinned, the wood removed paying in part for the work done and the remaining stand being left in better condition.

During the past two years damage from the chestnut bark disease has become more apparent in the State Forest, and experiments have been started to determine the practicability of checking the progress of the disease on a definite area by removing all infected trees. No definite results have as yet been obtained, except that it is evidently impossible to locate all the diseased trees without going over the ground more than once. This subject will be more fully discussed in the report of the Botanist (Part V).

Some portions of this Forest had been so severely culled before purchase by the State that very little growth of value remained. One such area of about 15 acres was cleared and planted with pine in the spring of 1912. Another tract with a good growth of chestnut sprouts large enough for small poles, was damaged by fire in 1908. Following the fire most of the trees became infected with blight to such an extent that the timber was sold to a lumberman. The best of it has already been removed, and after the cordwood is cleaned off the area will probably be planted to pine. Adjoining areas of cutover land will be added to the Forest whenever they can be advantageously purchased, and will be planted with coniferous trees in most cases.

A total area of about 30 acres has already been planted with white pine, red pine and Norway spruce, and other land will doubtless be so planted each year. Only the more valuable and more rapid growing stands of hardwoods will be maintained as such, the poorer quality and slower growing stands being transformed into a more profitable coniferous type as rapidly as possible. These will permit of more intensive management, since the more valuable prospective yield will warrant a larger expenditure in protection and management.

To carry out this work systematically, a working plan for a short term of years is desirable. Most of the necessary data was gathered during 1912 and the publication of such a plan as a Station Bulletin is anticipated during the coming year. It will include a type and stock map of the Portland State Forest showing the present stand with recommendations as to future treatment.

The Union State Forest is a tract of 288 acres in the town of Union purchased in 1905. Much of it was open farm land of rather poor quality, and was purchased at an average price of a little over $3 per acre. As there was practically no timber of value on the area, no improvement cuttings have been made but considerable planting has been done on the open land. In all, about 55 acres were planted with white pine, and two small areas of about 2½ acres each were planted with Scotch pine and European larch respectively. In the spring of 1912, failures in all the plantations were filled with two-year Scotch pine seedlings, making an irregular mixture of white pine and Scotch pine throughout most of the planted area. Scotch pine was used for this purpose because its more vigorous growth would give it a chance to overtake the already established white pine. As this tract is situated in a pine region, it is particularly desirable that a good stand of pine be established. Considerable work has been necessary in checking the white pine weevil during the past two seasons. The mixture of Scotch pine with the white pine should tend to reduce the damage from this cause, as the weevil does not thrive in the former species.

The Simsbury State Forest consists of 130 acres of brush and cut-over land which had been considerably damaged by fire before purchase by the State in 1908. As the tract is crossed by a railroad, a good opportunity was presented to practice protection from fire, and with the exception of one fire in 1910, this has been successful. Twenty acres have been planted with Scotch pine, twenty-two acres with white pine and three acres or more with red pine, European larch and Japanese red pine. It is intended to extend these plantations from year to year until the entire tract is growing pine instead of the present growth of poor quality hardwoods. The soil is rather light and sandy throughout most of the area, and should be well suited for the growth of pine. Fire lines have been cleared along the railroad track and across the tract so as to make protection from fire practicable. This forest is accessibly located and as a demonstration area has decided advantages, but it is not large enough to be economically managed, and it is hoped that more land may be acquired before many years.

THE STATION FORESTER.

It has already been stated that the work of the Station Forester follows three lines; investigation, experiment and dissemination of information. These lines are closely associated and often overlap. In many cases, an investigation involves experiments, and experiments may require preliminary investigation. The publication of results, in either case, is an educational measure intended to increase the knowledge of forestry methods and an interest in their practical application, as a means of obtaining improved forest conditions and increased forest values.

The improvement of the present forest so as to secure its maximum yield, and the increase of the forest resources of the State by more intensive use of land suitable only for forest growth, are two distinct problems, although they have much in common. In the greater part of the State, the present forest consists of second growth hardwoods with a large percentage of chestnut, either in pure stands or mixed with other species. These chestnut stands have been considered a source of profit to their owners in the past, and because of their ability to renew themselves by sprouts and to grow rapidly on good sites, have been cut clean at intervals of from twenty to forty years. For several generations the market for railroad ties, telephone poles and other products for which chestnut is adapted, has been very good, and no other hardwood tree has been such a source of revenue to the Connecticut farmer. Because of its greater sprouting ability and more rapid growth it seems probable that chestnut has increased in quantity in the State during the past fifty years as compared with other hardwood species which formerly grew in mixture with it.

Other factors have been at work during recent years, however, which bid fair to rob the chestnut of its supremacy as a favorite timber tree. The cutting of successive generations of sprouts with practically no regeneration by seed has inevitably resulted in a less vigorous and shorter-lived stand. In many cases, failure of some stumps to sprout, or the destruction of some sprouts by drought, winter-killing or fire has produced a more open stand, or given a chance for light-seeded weed trees like poplar or birch to become a part of the stand. Thus many stands of chestnut have gradually deteriorated until to-day they are not producing half a cord per acre of valuable wood per year.

Fire has had a great deal to do with this deterioration, for chestnut is thin-barked and not fire-resistant like most oaks. It is therefore more easily damaged, and even surface fires will sometimes completely destroy stands of chestnut sprouts big enough for posts. Older and heavier barked trees are often so seriously damaged that large patches of bark are killed and loosen up for several feet above the base of the tree in time. A second fire finds easy access to the wood itself, and even though no second fire occurs, the loosened bark gives a chance for insects and fungi to enter the wood, so that decay at the base of the tree is almost sure to follow fire. The roots are often injured also and a decrease in vitality follows, so that when the tree is cut, it not only proves to be unsound, but is lacking in sprouting ability. Occasionally fire scars heal over so that they are not apparent on the outside, but this is less apt to happen with chestnut than with oak, and even a scar which has completely healed is a detriment to the quality of the log in which it occurs.

Improvement of the present forest to secure its maximum yield involves protection from further damage by fire. This is so evidently essential that its need will not be further emphasized here. Something besides protection from fire is necessary, however, if the maximum yield is to be secured from any stand of forest trees. Improvement thinnings should be made from time to time to remove, 1st, weakened and suppressed trees which can never produce first-class material and will probably succumb to competition anyway; 2d, trees of inferior species which if left will not only interfere with the growth of better individuals but tend to increase the quantity of inferior material in the stand; 3d, crooked or damaged trees which, while preventing the best development of other trees, will never be worth much themselves. Such thinnings not only prevent much waste of material, but if properly made with due regard to maintenance of the crown cover, hasten the maximum development of the most valuable trees in the stand.

Thinnings are as essential to the production of a timber crop as thinning and weeding are to the production of a crop of beets or onions. Theoretically, thinnings should be made in a wood lot just as soon as the trees begin to crowd each other, but in practice it is customary to wait until the products of a thinning will approximately pay its cost. Later thinnings yielding larger material may show a profit, but an increased final yield would warrant such cultural operations in most cases, even though at some expense.

Cuttings are sometimes necessary for the express purpose of removing trees injured by fire, wind, drought, insects or fungi in order that the damaged material may be utilized, and in the case of insects and fungi, that further damage may be prevented if possible. Such damage cuttings are usually only of local importance, and confined to a small area, but occasionally the ravages of an insect pest or a fungous trouble may affect a considerable territory, and destroy a large part of its forests.

Just at present chestnut in this region is suffering from a fungous trouble (the so-called chestnut bark disease or blight) which has already killed a large proportion of the chestnut trees in south-western Connecticut and is known to exist all over the State (see Botanist's Report). As the fungus is a parasite which cannot be very successfully treated with a fungicide, and as it spreads by means of spores probably carried by the wind and insects, the only way of checking it seems to be by the complete destruction of the diseased trees, which may be sources of infection. The expense of this operation would render it impractical in stands not yet of merchantable size where diseased trees are abundant. The removal of isolated infected trees would probably tend to check the spread of the disease, but since it is impossible to detect the presence of the disease when the infection first takes place, it is difficult to eliminate the trouble even by such radical methods.

If the spread of the disease has been assisted by a weakened condition of the chestnut trees due to the abnormal climatic conditions of the past ten years, and which have produced winter and drought injuries in many trees, it seems reasonable to believe that a return of normal conditions would be followed by a decrease in the spread of the trouble. As is stated in the Botanist's Report (q. v.), there is some reason to believe that such a decrease is already becoming apparent. It is not to be expected that trees already infected will be able to throw off the disease and entirely recover from it (although some instances have been noted where scars of blight cankers have partially healed), but if the disease gradually dies out as a result of natural causes, it is possible that chestnut stands will be more or less completely renewed by sprout and seedling growth free from disease.

The fact must be recognized, however, that many formerly thrifty chestnut stands have been completely destroyed and that at best only a partial natural regeneration of diseased stands can be anticipated for many years. If, then, land which has grown chestnut timber profitably in the past is to be continued as forest land, immediate measures should be taken to secure the quickest and best results. It is merely a common sense precaution on the part of the community as well as that of the owner, to make sure that land which has been the source of revenue in the past shall continue to yield at least an equal revenue in the future. From a business point of view, it is equally sensible to consider the possibility of increasing this revenue by growing the kind of timber which will produce the largest value in the shortest time.

If chestnut is the most profitable timber which can be grown where chestnut formerly grew, a fully stocked stand of this species should be established, by planting if necessary, just as soon as there is reasonable assurance of safety from the chestnut blight. If some other species than chestnut will produce quicker returns or larger profits, a considerable investment in planting such species might be warranted. Such an investment would certainly prove more profitable than to allow land formerly bearing chestnut to lie idle, or to allow it to seed up with species of small value like birch and poplar, or slow-growing species like black oak and hemlock. Even though chestnut were entirely free from disease at the present time, there are many situations where some species other than chestnut would produce better results. For instance, there are many ridges in Connecticut where chestnut does not grow to more than cordwood size in forty years. Unless very favorably situated with regard to market, such timber cannot be handled at a reasonable profit, and with a long haul to market, no profit can be anticipated. This is also true of many oak and mixed hardwood stands growing on poor soils. After cutting such timber, its replacement with a plantation of rapid growing conifers such as white pine or Scotch pine, would promise much greater returns than could be secured from natural regeneration. The greater value of the resulting product and the shorter period necessary to produce it, would render the investment involved worth while.

Much land in Connecticut best suited for forest growth is now practically non-productive as the result of fires. Much other land formerly used for grazing or cultivation, but now reverting to forest on account of changed economic conditions, may be considered as idle land for the time being, since the present timber growth is of poor species or is too scattered to produce valuable material. All such non-productive and idle land which is better suited for forest growth than any other purpose should be made use of for forest planting with the species best adapted to the situation. This policy if systematically carried out, and followed up with intensive methods of forest management, will not only increase the productiveness of Connecticut forest lands, but will furnish many Connecticut industries with raw material which is now brought in from other states.*

With a view to advising land owners regarding the best methods of handling their forest lands, or regarding the afforestation of idle lands, the Station authorizes its foresters to make examinations without charge other than the necessary expenses for transportation, etc. Reports of such examinations give a statement of the condition of the forest land examined, and recommend a general plan for its future management. So far as possible, practical demonstrations and instructions are given for the work involved, but direct supervision cannot be furnished, nor can estimates of standing timber be made for the purpose of sale or purchase. This work rightly belongs to foresters outside the employ of the State, and such men will be recommended when desired. During the past few years the Station has supplied stock for forest planting at cost in order to encourage such work, but the development of commercial nurseries for the production of such stock at a reasonable price will relieve the Station of this necessity after the present season. The time required in attending to the nursery work and shipment of trees can be better spent in carrying on other work of the department. Assistance in securing such stock will be cheerfully rendered, however, and every effort will be made to assure satisfactory results.

---

* See Bulletin 174.

oul

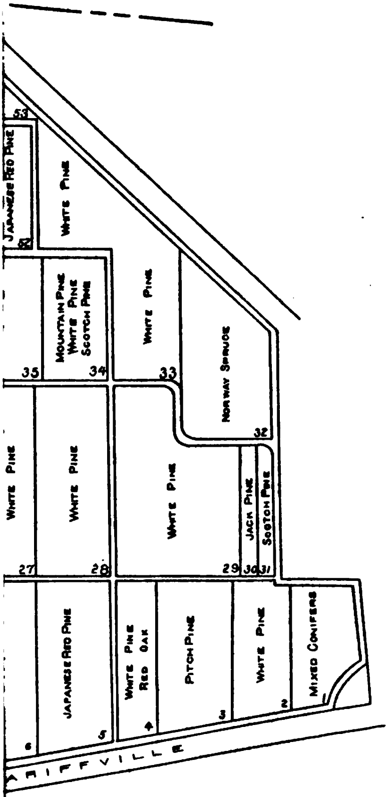
now
ther
vert-
may
esen
duce
which
ould
apted
, and
, wi
ands
teria

bes
fores-
make
enses
ive a
l rec-
ar as
n for
ished
ose of
; out-
ended
; sup-
: such
r the
e the
time
trees
ment
dered
actory

PLANTATIONS

EXPERIMENT STATION

Windsor Conn.



RAINBOW FOREST PLANTATIONS.

Since 1902 the Connecticut Agricultural Experiment Station has conducted experiments in forest planting on a tract of land at Rainbow in the northern part of the town of Windsor. This land is part of a natural sand plain and represents one type of non-agricultural land in the state better suited for forest growing than anything else. The soil is very sandy, poor in quality and loses moisture rapidly in periods of drought.

The tract may be reached by electric car marked "Rainbow" from Hartford via Windsor. The plantations lie about one-half mile west of the village of Rainbow, between the Tariffville and East Granby highways near their junction. Mr. Henry Palmer, who lives near the Rainbow postoffice, is local superintendent and will gladly conduct visitors through the plantations.

The following descriptions of experimental plots and the accompanying map have been prepared as a guide to those who wish to examine the plantations. The knowledge thus far gained from these experiments has been included with the data from private planting in preceding pages of this report. It is anticipated that the results secured from these plantations by intensive management will prove of considerable interest and value. They will be published in future reports and bulletins of this Station.

Description of Experimental Plots.

***Plot No. 1.** Austrian pine, Scotch pine, European larch, Douglas fir, Chinese arbor-vitæ. Area about 1 acre. Spring 1907, east side, Austrian pine, 2-year seedlings, spacing 5 x 5 feet; middle, European larch, 2-year seedlings, spacing 5 x 6 feet; west side, Scotch pine, 2-year seedlings, spacing 5 x 5 and 6 x 6 feet. Spring 1911, area partially burned over, destroying some of each species. Spring 1913, burned area planted with 7-year Douglas fir transplants and 6-year Chinese arbor-vitæ seedlings. This plot will show the comparative growth of several exotic conifers on poor soil.

---

* Partially destroyed by fire in 1911.

***Plot No. 2.** White pine. Area .9 acre. Spring 1907, experiment to determine comparative results of different spacing. 6 x 6 feet, 5 x 5 feet, 4 x 4 feet, 3 x 3 feet. Spring 1913, trees destroyed by fire replaced with 8-year white pine transplants.

Plot No. 3. Pitch pine. Area 1.3 acres. Spring 1902, seed sown on cultivated strips 1½ feet broad and 4 feet apart. South half of plot at rate of 2 pounds per acre, north half at rate of 1 pound per acre. Seed lightly covered by brushing the surface in both cases. Result shows that a stand of this species may be successfully established in this manner. Two pounds of seed per acre gives too dense a stand; 1½ pounds would be sufficient. Losses have not exceeded five per cent. Pitch pine is of very little commercial value in this region, however.

Plot No. 4. Red oak and white pine. Area .8 acre. Spring 1904, solid rows of oak alternating with oak and pine; spacing 6 x 6 feet. Oak secured by seedspot method, three acorns to a spot. 2-year white pine seedlings used. Loss small for first three years; since then oaks have been kept cut back to ground by rabbits with a few exceptions. Pines bushy and poorly formed, due to lack of crowding and attacks of white pine weevil. This mixture does not appear to be a practical one since pine grows faster and is a better tree for a sandy site than red oak. If used on such sites, oak should be given several years start.

Plot No. 5. Japanese red pine. Area 1.5 acres. Spring 1910, 2-year seedlings, spacing 6 x 6 feet. Failures nearly 50 per cent. the first season. Spring 1911, blanks filled with 3-year transplants. Heavy loss due to drought, following both plantings. Living stock is thrifty. Spring 1913, blanks filled with 4-year white pine transplants.

Plot No. 6. Western yellow (bull) pine. Area 2.5 acres. Spring 1908, 2-year seedlings, spacing 5 x 5 feet. Loss approximately 45 per cent., due to drought and fungous disease (*Peridermium pyriforme*). This is a Western species which seems to adapt itself poorly to dry sandy soils in Connecticut, grows slowly and sustains much loss from drought. 1912, average height 1.1 feet, maximum 2 feet. Spring 1912 and 1913, blanks filled with 4-year white pine transplants.

---

* Partially destroyed by fire in 1911.

Plot No. 7. Chestnut. Area 2.4 acres. 1902-1903, spring and fall seeding and spring planting. 1912, 10 to 15 per cent. living. Trees scattered and range in height from 2 to 4 feet. Individual development poor. The plantation is practically a failure and will be replanted.

Plot No. 8. Chestnut. Area 2.3 acres. Spring 1903, 1-year seedlings, spacing 5 x 5 feet, 6 x 6 feet, 7 x 7 feet, in three parts from south to north. Losses large and many trees show drought and winter injury. Results unsatisfactory. A few groups show fair development, individuals ranging from 3 to 5 feet in height.

Plot No. 9. Natural growth of hardwoods. Area .6 acre.

Plot No. 10. Chestnut sprouts. Area .6 acre. Natural growth, 50 to 60 years old. Trees damaged by fire and other causes were removed in 1912.

Plot No. 11. Gray birch and white pine. Area .7 acre. Scattered natural white pine reproduction underneath birch.

Plot No. 12. White pine. Area .5 acre. Spring 1902, 3-year seedlings planted under gray birch. 15 to 20 feet tall, spacing 5 x 5 feet. 1903, blanks filled with 3-year transplants of same species. Little subsequent loss and little injury by white pine weevil. 1910, birch removed from north half. 1911, birch removed from south half. Slow growth during first ten years resulted from the shade.

Plot No. 13. Natural growth of pitch pine and hardwoods. Area 1.2 acres. Spring 1910, balsam fir transplants set irregularly under pitch pine. Fir shows very little growth in three years.

Plot No. 14. Scotch pine. Area 1.2 acres. Spring 1907, 2-year seedlings planted in furrows ploughed through brush, spacing 5 x 6 feet. 1910, brush cleaned from part of plot so as to free Scotch pine. 1913, balance of plot cleaned.

Plot No. 15. White pine. Area 1 acre. Spring 1906, 3-year seedlings, spacing 5 x 6 feet. 1912, shows 10 per cent. loss; remaining trees thrifty. 1913, brush cleaned from plot.

Plot No. 16. Not planted. Area 3.7 acres.

Plot No. 17. Nursery site. Not planted. Area 1 acre.

Plot No. 18. Natural growth of pitch pine. Area .8 acre.

Plot No. 19. Japanese red pine. Area 1.2 acres. Spring 1910, red pine 2-year seedlings, spacing 6 x 6 feet. 50 per cent. loss the first year. May 1911, blanks filled with 3-year transplants of same species. Heavy loss the following season, due to drought as in the previous year.

Plot No. 20. White pine and Scotch pine. Area 1.5 acres. Spring 1910, 4-year white pine transplants and 2-year Scotch pine seedlings in alternate rows, spacing 5 x 5 feet, to replace hardwood trees of the previous experiment, some of which remain but were disregarded in replanting as they have grown very slowly. Some older white pines remain from planting of 1904. Loss heavy in Scotch pine as result of subsequent drought and use of slender stock grown too densely in seedbeds.

Plot No. 21. White pine and Scotch pine. Area 1.5 acres. Spring 1910, same planting as No. 20 and similar conditions.

Plot No. 22. Red pine. Area .9 acre. Spring 1902, 4-year transplants, spacing 4½ x 5 feet. Example of a practically perfect plantation. (Should be compared with other species planted the same year, Plots 23, 24, 25.) On north end of this plot white pine was used in place of red pine.

Plot No. 23. Scotch pine. Area .6 acre. Spring 1902, 3-year seedlings, spacing 4 x 5 feet. 1904, blanks and narrow space on north end filled with 2-year Scotch pine transplants. Example of practically perfect plantation. (Should be compared with other species planted same year, Plots 22, 24, 25.) 1911, trees closed together, grass shaded out and lower branches beginning to die as a result of dense shade.

Plot No. 24. Red pine and Austrian pine. Area .5 acre. Spring 1902, 4-year seedlings of red pine, spacing 4½ x 5 feet. July 1902, 4-year seedlings Austrian pine were planted on south end of plot with the same spacing. 1911, height of red pine on this plot averaged 2 feet more than on Plot 22; probably due to more protected position, better soil conditions or both. Spring 1905, north end of plot filled out with white pine.

Plot No. 25. White pine. Area .8 acre. Spring 1902, wild seedlings 8 to 18 inches tall, spacing 4½ x 5½ feet. 1903, blanks filled with white ash, green ash, basswood and tulip seedlings. 1904-1905, blanks filled with white pine wild seedlings. 1911, most of hardwoods had disappeared, stand is irregular and lacks uniformity of growth as a result of difference in quality of stock, replacing of failures several years after original planting and damage by white pine weevil.

Plot No. 26. White pine. Area 1.2 acres. Spring 1903, 2-year transplants, spacing 4 x 4 feet, 5 x 5 feet, 6 x 6 feet. Divided in three parts to determine the effect of different spacing. 1911, the closest spacing at north end apparently produced best height growth; considerable injury by white pine weevil, however, made it impossible to determine this fact absolutely by measurement of heights.

Plot No. 27. White pine. Area 1 acre. Spring 1904, two rows of pine alternating with two rows of chestnut 1-year seedlings, spacing 5 x 5 feet. Chestnut was a complete failure. 1910, failed rows filled with 4-year white pine transplants to determine possibility of using younger stock of same species for filling in established plantation.

Plot No. 28. White pine. Area 1.6 acres. Spring 1902, 3 and 4-year seedlings and transplants, spacing 4 x 5 feet. North end cultivated and fertilized for several seasons, resulting in some apparent increase in height growth. Severe injury by white pine weevil has prevented definite determination of this fact.

Plot No. 29. White pine. Area 2.3 acres. Fall 1907, 3-year transplants, spacing 5 x 5 feet. A test of fall planting. Result is a practically complete plantation, indicating that under favorable weather conditions early fall planting may succeed as well as spring planting on sandy soil.

Plot No. 30. Jack pine. Area .25 acre. Spring 1908, seedlings from Michigan, 1-2 feet tall, spacing 5 x 5 feet. Trees have grown very slowly. Species probably of small importance for eastern planting, although native to sand plains in Lake States.

Plot No. 31. Scotch pine. Area .3 acre. Spring 1904, 2-year seedlings, spacing 5 x 5 feet. In every other row, the alternate plants were green ash 1-year seedlings which subsequently died, leaving the pines 10 feet apart in the alternate rows. These blanks have been left unfilled in order to determine the effect of this wide and uneven spacing on the development of Scotch pine.

Plot No. 32. Norway spruce. Area 1.5 acres. Spring 1905, 2-year seedlings, spacing 5 x 5 feet under an open growth of pitch pine. Ground had been burned over just previous to planting. Fall 1907, another fire burned over a portion of the area. Spring 1910, part of the blanks filled with 4-year transplants Norway spruce. 1911, trees alive on 50 per cent. of the area but showed poor development, especially under dense shade. 1913, overwood partly removed so as to give Norway spruce more light, and blanks filled with 7-year transplants.

Plot No. 33. White pine. Area 1.5 acres. Spring 1905, 2-year seedlings, spacing 5 x 5 feet, under pitch pine giving medium shade. The trees are not well developed on account of shade but uninjured by white pine weevil. 1913, pitch pine thinned to give white pine more light.

Plot No. 34. Scotch pine, white pine and mountain pine. Area 1 acre. Spring 1911, 4-year transplants of Scotch pine and 3-year seedlings of mountain pine planted in alternate rows, spacing 6 x 6 feet. A large per cent. of the latter died from effect of drought the same season. Spring 1913, failures filled with 5-year white pine transplants.

Plot No. 35. White pine and Scotch pine. Area 2.3 acres. Spring 1903, original planting, 2-year white pine transplants in groups mixed with hardwood seedlings, spacing 4½ x 5 feet. Spring 1904, failures in white pine filled with 3-year transplants. Spring 1911, hardwoods mostly dead; replaced with 3-year Scotch pine transplants to determine whether the Scotch pine would overtake the older white pine.

Plot No. 36. White pine and Scotch pine. Area 1 acre. Spring 1903, original planting, 2-year white pine transplants in mixture with hard maple, spacing 6 x 6 feet. Solid rows of maple, maple and pine alternating in every other row. Maple was a complete failure. Spring 1908, blanks filled with 2 and 3-year Scotch pine seedlings. Rapid growing Scotch pine should be able to catch up with white pine and form good mixed forest.

Plot No. 37. White pine and Scotch pine. Area 1 acre. Spring 1903, original planting same as Plot 36. Spring 1911, blanks in hardwoods filled with 3-year Scotch pine transplants.

Plot No. 38. White pine, Douglas fir. Area .4 acre. Spring 1903, pine and fir planted on most of the plot and pine alone at the north end. Spacing is very irregular, due to failure of hardwoods planted in the original experiment; blanks not filled; plantation left for comparison of pine and fir.

Plot No. 39. White pine. Area .7 acre. Spring 1903, ash, maple and other hardwoods alternating with pine, original spacing 5 x 5 feet. Hardwoods have failed, leaving pine with present spacing of 10 x 10 feet, which will be left to demonstrate the effect of wide spacing on growth and condition of the trees.

Plot No. 40. Red oak. Area 1 acre. Spring 1903, red oak acorns planted in spots, 1 acorn in each spot, on northerly half of plot, with spacing 5 x 5 feet. On the southerly half of plot 2 acorns were planted in each spot with a spacing of 6 x 6 feet. 1904, failed places were filled. 1907, brush cleaned from entire plot. 1911, one-third of the trees showed injury by rabbits.

Plot No. 41. White pine and Norway spruce. Area .25 acre. Spring 1906, pine and spruce 2-year seedlings in alternate rows, spacing 5 x 6 feet. Most of the trees were planted under light brush and show effect of the competing growth by more slender forms. Best development secured where no brush was present.

Plot No. 42. White pine and Norway spruce. Area 2.7 acres. Spring 1906, alternate rows of pine and spruce 2-year seedlings, spacing 5 x 6 feet under a medium dense growth of birch and pitch pine on most of the area, but varying to open growth and scattered trees at north end of plot. March and April 1911, overwood removed from south half and subsequently the spruce and pine suffered considerable injury from late frost, exposure and drought. May 1911, blanks filled with 5-year white pine transplants.

Plot No. 43. White pine and Norway spruce. Area 4.25 acres. Spring 1906, same experiment as Plot 42 but overwood not removed.

Plot No. 44. White pine. Area 3.2 acres. Spring 1906, 2-year white pine seedlings alternating with hard maple, except on west side where white pine was planted pure, spacing 5 x 6 feet. Medium dense overwood of birch and pitch pine on about half of area. Most of maples failed. Spring 1910, blanks filled with 4-year white pine transplants.

Plot No. 45. Mountain pine. Area 4.5 acres. Spring 1912, 3-year transplants, spacing 6 x 6 feet. Heavy losses during subsequent dry summer. A few scattered Corsican pines are left from an unsuccessful planting of 1910.

Plot No. 46. White pine and Norway spruce. Area .7 acre. Spring 1906, pine and spruce 2-year seedlings in alternate rows, spacing 5 x 6 feet. May 1908, blanks filled with jack pine.

Plot No. 47. Douglas fir and jack pine. Area 1 acre. Spring 1903, Douglas fir and various hardwoods in an irregular mixture, spacing 5 x 5 feet. Hardwoods mostly failed. Spring 1908, blanks filled with jack pine.

Plot No. 48. Red oak and white pine. Area 1 acre. Spring 1904, oak 1-year seedlings, pine 2-year seedlings; four rows of oak and two rows of pine, spacing 6 x 6 feet. Plantation shows good growth but the red oak is too branchy and not always straight in form. 1911, pines were outstripping the oaks in growth.

Plot No. 49. Pitch pine. Area 1 acre. Spring 1903, 2-year seedlings, spacing 5 x 5 feet. 1911, 94 per cent. living.

Plot No. 50. Red oak. Area 1 acre. Spring 1904. 1-year seedlings, spacing 6 x 6 feet. 1911, 90 per cent. living but very few well developed. The site is too poor and dry. Rabbits have done much damage.

Plot No. 51. Red oak and white pine. Area 1 acre. Spring 1904, oak 1-year seedlings and pine 2-year seedlings; two rows oak, one row pine, spacing 6 x 6 feet. Growth and form of trees generally poor.

Plot No. 52. Japanese red pine and white pine. Area 1 acre. Spring 1910, 2-year seedlings of each species in alternate rows, spacing 6 x 6 feet. Losses were very heavy, the red pine being winter-killed and both species suffering severely from drought during the seasons of 1910-1912.

Plot No. 53. White pine. Area .3 acre. Spring 1905, 2-year seedlings, spacing 5 x 5 feet. Spring 1910, blanks filled with 3-year white pine transplants.

Plot No. 54. White pine and Japanese black pine. Area .9 acre. Spring 1910, white pine 3-year transplants, black pine 2-year seedlings in alternate rows, spacing 6 x 6 feet.

Plot No. 55. White pine. Area 1 acre. Spring 1903. 2-year seedlings in mixture with beech. Spacing 6 x 6 feet. 1904, failures in pine replaced with 3-year transplants. The beech is a failure and the remaining pine is too far apart for best development.

Plot No. 56. White pine and Scotch pine. Area 1 acre. Spring 1903, 2-year seedlings, pine alternating with beech and every other row solid beech. Spring 1911, the beech having failed was replaced with Scotch pine 3-year transplants.

Plot No. 57. Chestnut and beech. Area 1 acre. Spring 1903, seedlings planted alternately in rows, spacing 5 x 5 feet. 1904, failures replaced with seedling stock. 1911, some trees of each species living but poorly formed and plantation is practically a failure, the site being too poor for these species.

Plot No. 58. Black locust. Area 1 acre. Spring 1903, 1-year seedlings, spacing 4 x 4, 5 x 5, and 6 x 6 feet. Many trees were girdled and killed by rabbits. Trees on north end have grown fastest. In 1911 these ranged from 15 to 25 feet in height and 1 to 5 inches in diameter breast high. Nearly all seriously injured by the locust borer.

Plot No. 59. White pine, black birch. Area about 1.1 acres. Spring 1903, 2-year transplants, spacing 5 x 5 feet at south end of plot. Spring 1904, white pine 3-year transplants alternating with black birch nursery seedlings, spacing 5 x 5 feet on balance of plot. Black birch has failed or grown very slowly and present wide spacing of pine has resulted in poor development.

Plot No. 60. White pine. Area 2 acres. Spring 1905, 2-year seedlings and 3-year transplants, part set in furrows and part on hills between, spacing 5 x 5 feet.

Plot No. 61. White pine. Area about 2 acres. Spring 1913, 5-year transplants partly in and partly between old furrows, spacing 5 x 6 feet. A few chestnut trees left from planting of 1905 were ignored in replanting because so small and poorly developed.

Plot No. 62. White pine. Area 5.7 acres. Spring 1907, 2-year seedlings, spacing 5 x 5 feet. Very few failures.

Plot No. 63. Area 2.4 acres. Not planted.

Plot No. 64. Scotch pine. Area 1.3 acres. Spring 1910, 2-year seedlings, spacing 6 x 6 feet. A few chestnut trees remain from a previous planting.

Plot No. 65. Area .8 acre. Not planted.

Plot No. 66. Western yellow (bull) pine. Area 1.6 acres. Spring 1908, 2-year seedlings, spacing 5 x 5 feet. Conditions similar to that of Plot No. 6. Some loss from fungous trouble (*Peridermium pyriforme*).

Plot No. 67. Area .2 acre. Scattered natural growth of pitch pine.

Plot No. 68. White pine. Area 4.4 acres. Spring 1905, collected wild stock from Stafford, 2-year nursery seedlings and 3-year transplants, spacing 5 x 5 and 6 x 6 feet. Height growth varies greatly in different parts of the plot with the age, size and quality of stock, and variation in site conditions.

Plot No. 69. White pine and Norway spruce. Area 4 acres. Spring 1905, 2-year seedlings of pine alternating in each row with 2-year seedlings of spruce, spacing 5 x 5 feet. Norway spruce does not equal white pine in height growth on this sandy, dry site and suffers greater loss.

Plot No. 70. Austrian pine. Area 1 acre. Spring 1908, 2-year seedlings, spacing 6 x 6 feet. 1912, most of the trees suffered severely from drought; very few show good development.

LIST OF EXPERIMENTAL PLOTS.

Plot	1,	formerly	A1	Scotch pine, Austrian pine, European larch, Douglas fir, Chinese arborvitæ, Norway spruce, white pine, pitch pine.
"	2,	"	A2	White pine.
"	3,	"	A3	Pitch pine.
"	4,	"	A4	Red oak, white pine.
"	5,	"	A5	Japanese red pine, white pine.
"	6,	"	A6	Western yellow pine, white pine.
"	7,	"	A7	Chestnut—scattering.
"	8,	"	A8	Chestnut.
"	9,		—	Chestnut and other hardwoods—natural growth.
"	10,		—	Chestnut.
"	11,		—	Gray birch.
"	12,	"	A9	White pine.
"	13,		—	Pitch pine, balsam fir.
"	14,		—	Scotch pine.
"	15,	"	B15	White pine.
"	16,		—	Not planted.
"	17,		—	Nursery site.
"	18,		—	Pitch pine.
"	19,	"	B14	Japanese red pine.
"	20,	"	B13	White pine, Scotch pine.
"	21,	"	B12	White pine, Scotch pine.
"	22,	"	B11	Red pine.
"	23,	"	B10	Scotch pine.
"	24,	"	B9	Red pine, Austrian pine, white pine.
"	25,	"	B8	White pine.
"	26,	"	B7	White pine.
"	27,	"	B6	White pine.
"	28,	"	B5	White pine.
"	29,	"	B4 & B3	White pine.
"	30,	"	B2	Jack pine.
"	31,	"	B1	Scotch pine.
"	32,	"	BC1	Norway spruce.
"	33,	"	BC2	White pine.
"	34,	"	C1	Scotch pine, white pine, mountain pine.
"	35,	"	C2	White pine, Scotch pine.
"	36,	"	C3 (East)	White pine, Scotch pine.
"	37,	"	C3 (West)	White pine, Scotch pine.
"	38,	"	C4	White pine, Douglas fir.
"	39,	"	C5	White pine.
"	40,	"	C6	Red oak.
"	41,		—	White pine, Norway spruce.
"	42,	"	D7 (East)	White pine, Norway spruce.
"	43,	"	D7 (Center)	White pine, Norway spruce.

Plot 44,	formerly	D7 (West)	White pine.
" 45,	"	D8	Mountain pine, Corsican pine.
" 46,	"	D7	White pine, jack pine, Norway spruce.
" 47,	"	D6	Jack pine, Douglas fir.
" 48,	"	D5	White pine, red oak.
" 49,	"	D4	Pitch pine.
" 50,	"	D3	Red oak.
" 51,	"	D2	White pine, red oak.
" 52,	"	D1	Japanese red pine, white pine.
" 53,	"	DE1	White pine.
" 54,	"	DE2	Japanese black pine, white pine.
" 55,	"	E1	White pine.
" 56,	"	E2	White pine, Scotch pine.
" 57,	"	E3	Chestnut, beech.
" 58,	"	E4	Black locust.
" 59,	"	E5	White pine, black birch.
" 60,	"	E6	White pine.
" 61,	"	E7	White pine, chestnut.
" 62,	"	F5	White pine.
" 63,	"	F4	Not planted.
" 64,	"	F4	Scotch pine.
" 65,	"	F4	Not planted.
" 66,	"	F4	Western yellow pine.
" 67,		—	Pitch pine.
" 68,	"	F3	White pine.
" 69,	"	F2	White pine, Norway spruce.
" 70,	"	F1	Austrian pine.

List of Species Used on Experimental Plots.

PINES.

Austrian Pine, *Pinus Laricio, var. austriaca.*

A native of Europe, where it is grown to some extent for timber; well adapted to dry, sandy soils. Plots 1, 24, 70.

Bull (Western Yellow) Pine, *Pinus ponderosa.*

A common timber tree of the western United States; usually found in dry situations. Plots 6, 66.

Corsican Pine, *Pinus Laricio.*

A native of southern Europe, where it attains large size, but is not hardy in New England. Plot 45.

Jack Pine, *Pinus divaricata.*

A native of Canada and the northern border of the United States; especially fond of sterile, sandy soils. Plots 30, 46, 47.

JAPANESE BLACK PINE, *Pinus Thunbergii.*
A native of China and Korea; used successfully in Japan for planting on sand plains. Plot 54.

JAPANESE RED PINE, *Pinus densiflora.*
A native of the mountains of Japan, where is grows to large size. Plots 5, 19, 52.

MOUNTAIN PINE, *Pinus montana.*
Native to the mountains of central Europe, where it does not attain large size. Plots 34, 45.

NORWAY PINE, *Pinus resinosa* (see red pine).

PITCH PINE, *Pinus rigida.*
The native yellow pine of New England, which reaches its best development further south; grows well on sandy soils, but is not of much commercial importance in this region. Plots 1, 3, 13, 18, 32, 33, 42, 43, 44, 49, 67.

RED (NORWAY) PINE, *Pinus resinosa.*
A handsome tree native to the northeastern United States and Canada; is almost entirely free from insect troubles, and has great possibilities for reforestation purposes. Plots 22, 24.

SCOTCH PINE, *Pinus sylvestris.*
The timber pine of Europe, especially well suited to dry, sandy situations. Plots 1, 14, 20, 21, 23, 31, 34, 35, 36, 37, 64.

WESTERN YELLOW PINE, *Pinus ponderosa* (see bull pine).

WHITE PINE, *Pinus strobus.*
The most valuable and adaptable of all pines; is native to this region and grows rapidly on light soils. In spite of its insect enemies and susceptibility to fire damage, it promises the best returns as a forest investment. Plots 1, 2, 4, 11, 12, 19, 20, 21, 25, 26, 27, 28, 29, 33, 34, 35, 36, 37, 38, 39, 41, 42, 43, 44, 46, 48, 51, 52, 53, 54, 56, 59, 60, 61, 62, 68, 69.

OTHER CONIFERS.

ARBOR-VITAE, CHINESE, *Biota orientalis.*
Native to the mountains of northern China. Plot 1.

FIR, BALSAM, *Abies balsamea.*
Native to northern United States and Canada. Plot 13.

FIR, RED, *Pseudotsuga taxifolia.*

One of the best timber trees of the Rocky Mountains and Pacific Coast States. Only the mountain form is hardy in this region. Plots 1, 38, 47.

LARCH, EUROPEAN, *Larix europaea.*

A species native to the mountains of central Europe. Plot 1.

SPRUCE, DOUGLAS, *Pseudotsuga taxifolia* (see red fir).

SPRUCE, NORWAY, *Picea excelsa.*

The common timber spruce of Europe. Plots 32, 41, 42, 43, 46, 69.

HARDWOODS.

BEECH, AMERICAN, *Fagus americana.*

A native tree of the northern United States and Canada; does not thrive on light sandy soils. Plot 57.

BIRCH, BLACK, *Betula lenta.*

Native to this region but not well suited for light sandy soils. Plot 59.

BIRCH, GRAY, *Betula populifolia.*

The common birch of old fields; thrives on dry soils, especially after vegetation has been removed by cultivation or burning. Plots 11, 42, 43, 44.

CHESTNUT, *Castanea dentata.*

The most common and useful timber tree of Connecticut in the past; establishes itself with difficulty on light sandy soils. Plots 8, 10, 57, 61, 64.

LOCUST, BLACK, *Robinia pseudacacia.*

A native species which thrives on poor soils, but is subject to injury by borers. Plots 17, 58.

OAK, RED, *Quercus rubra.*

The most rapid growing native oak; does fairly well on sandy soils. Plots 4, 40, 48, 50, 51.

OAK, WHITE, *Quercus alba.*

The most valuable native oak; of very slow growth, and not attractive for forest planting, especially on sandy soils. Plots 13, 17.

FOREST PLANTING IN CONNECTICUT.

By SAMUEL N. SPRING, M.F.

Professor of Forestry, Cornell University.

(Formerly State Forester of Connecticut.)

THE PROGRESS OF FOREST PLANTING.

Statistics recently gathered indicate that approximately 4,000 acres of land in Connecticut have been planted with forest trees since 1900. Forest planting for the purpose of making non-agricultural land productive of a profitable crop of timber is a very recent development in Connecticut, but is receiving more attention yearly, both in this and other states. Prior to 1900 a few land owners had planted small tracts, which were described in a previous report of the Station Forester.* At that time it was estimated that 635,000 trees had been set in recent commercial plantations, covering approximately 500 acres. Since then increasing interest has been shown each year in forest planting.

In order to determine the progress more definitely, circular letters were sent out in November, 1911, requesting a report from those known to have planted forest trees, and forms furnished for detailed records of all forest plantations. Returns were received from a little more than fifty per cent. of the owners and, with information previously secured, a record of two-thirds of the forest plantations established in Connecticut since 1901 was compiled. These returns have furnished much interesting information concerning different phases of planting, which will be presented in this report. Table I gives a summary of forest planting, by counties:

---

* Part IV, Biennial Report of the Connecticut Agricultural Experiment Station, 1907.

*TABLE I.

A SUMMARY OF FOREST PLANTING IN CONNECTICUT PREVIOUS TO 1912.

(Compiled from Reports of Owners in November 1911 and from Records in the State Forester's Office.

Name of County.	Area Planted. (Acres.)	Number of Trees Planted.			Number of Land Owners Who Planted.	Range in Area of Individual Plantations. (Acres.)	Number of Towns Where Planting Was Done.
		Conifers.	Broad Leaf Deciduous Trees.	Species Not Separated.			
Fairfield	122.5	115,800	2,000	....	18	.5– 60	9
Hartford	478.	540,400	†112,400	....	16	2.5–214	11
Litchfield	212.	269,850	6,400	....	17	1.0– 75	14
Middlesex	121.5	39,300	85,300	....	2	4.5–117	4
New Haven	604.	570,550	78,900	‡160,000	12	2.0–227	13
New London	92.5	47,000	....	....	8	1.0– 30	4
§Tolland	552.	529,300	....	....	10	1.0–400	10
Windham	110.5	158,500	....	....	18	1.0– 20	10
Totals	2293.0	2,270,700	285,000	160,000	101	.5–400	75

Total number of trees planted, 2,715,700.

* Does not include planting on State lands by State Forester.

† In addition there were 23½ bushels of seed used direct in reforestation on planting sites.

‡ Chiefly conifers but the number of each not given.

§ Includes some planting done by Union landowners in Woodstock and Ashford, Windham County.

According to the above table 2,715,700 trees have been planted and 2,293 acres forested with commercial species of forest trees. It may be assumed, since this represents two-thirds of those plantations known to have been established, that the whole acreage at the end of 1911 was 3,439.5. In the spring of 1912 the Connecticut Agricultural Experiment Station furnished 500,000 trees at cost for private owners who desired to plant forest. No record is available of the stock furnished by private nursery companies. With this added area planted in 1912, it is probable that not less than 4,000 acres of private forest have been established by planting within the past decade. This area is small in comparison with the large area of unproductive non-agricultural land in this state, but considering the lack of knowledge concerning the nature and value of forest planting and the difficulties of any new task, this progress is excellent.

TABLE II.

Area (Acres)	1–10	11–25	26–50	51–75	76–100	Over 100	Total
*Number of Plantations	70	17	4	3	0	7	101

In Table II the various plantations of which record was secured are classified according to area. They are located in all parts of the state and, as shown above, the majority are twenty-five acres or less in extent. The following seven land owners have planted more than 100 acres each:

A. B. & J. C. Wells, Southbridge, Mass. Plantations in Union, Ashford, and Woodstock, Conn.	400 acres
Harris Whittemore, Middlebury	227 "
Hartford Water Board, City of Hartford	214 "
Ansonia Water Company, Ansonia	165 "
New Haven Water Company, New Haven	142 "
Middletown Water Commission, City of Middletown	117 "
Isaiah Baker, Jr., Hartford	104 "

In nearly all cases, owners begin with a few thousand trees, perhaps only enough for one acre, twelve hundred trees, and then keep planting more each year. Experience with a small number at the beginning tends to ensure success then and in

---

*All planting done by one landowner is considered a single plantation in this record.

subsequent planting. A high percentage alive at the end of the first season is an indication that the planting was well done. Instances of complete or nearly complete failure are very few and these are usually traceable to a definite cause, such as heated stock, carelessness in handling, protracted drought following planting, etc. The majority of the plantations have been successful, the average showing a little more than 70 per cent. living—enough to ensure a good future forest crop. Many of the plantations range from 80 to 95 per cent. of trees alive and thrifty.

Initial cost is an important factor in final profit. The total cost per acre has seemed excessive in only five instances, when it ranged from $20.00 to $40.00 per acre. In the returns, the cost of planting (including cost of trees, labor and incidentals) was not always furnished. Such costs as were given are classified as follows:— (1) Those $15.00 per acre or less. (2) Those exceeding $15.00 per acre. The average cost per acre for planting for (1) was $9.68; for (2) $20.78. The average of all costs included under (1) and (2) was $11.86. Such a result may be considered very low since it is generally conceded that successful forest planting usually requires an expenditure of from $10.00 to $15.00 per acre according to conditions.

The principal species of conifers planted was white pine; to a less extent red or Norway pine, Scotch pine, Austrian pine and Norway spruce were used. The kinds of broadleaf deciduous trees chiefly used were oaks, hickories, maples and white ash.

The mistakes as well as the successful practice of forest planting by private land owners during the past ten years furnish information of value to all who undertake planting. The following discussion of forest planting embodies the experience thus gained and may serve as a guide for future work.

INFORMATION AND INSTRUCTIONS REGARDING FOREST PLANTING.

Planting Sites:

In general, forest planting should be confined to non-agricultural lands. Other lands will usually be required for field crops, for fruit-growing or for grazing, especially in view of the present growth of agriculture in the state. Increasing population will eventually demand the use of all lands profitable for the production of food. There will remain, however, not less than a million acres of non-agricultural land for natural or planted forest in Connecticut. Much land is without forest to-day which is fit only for forest growing, and there are some tracts now in woodland that will be cleared and devoted to agricultural development. The character of the soil and topography, accessibility to market, etc., are some of the factors determining future use of land. Forest planting will be an important part of the practice of forestry in making non-agricultural lands productive, and in renewing forest growth where fire and the chestnut bark disease have killed the trees.

The following classes of sites have been recognized in forest planting of the past decade:—

(1) *Open pasture land of poor quality* and farm land found to be unfit and unprofitable for such purpose because too steep, too stony, too thin or poor in soil, or otherwise unsuited for anything except forest growth. Nearly every farm has a greater or less area of this type of land. The owner is paying taxes on it yearly and receiving no income.

(2) *Brush land.* Under this heading those lands may be classed which, through cutting of the forest and subsequent fires, or on account of fire alone, have grown up to low, worthless brush or inferior trees. Brush pastures more recently abandoned may be included in this group, as well as formerly tilled fields that have proved unproductive and lie idle.

(3) *Recently cut-over sprout lands* incompletely stocked with valuable forest species. These should be planted with a sufficient number of trees to ensure complete use of the land and to supplement natural seedlings and sprouts, in order to produce a full yield of timber of good quality.

(4) *Woodland.* Open woodland, only partially stocked with forest, should be underplanted to secure a full yield and to improve forest conditions. Forests in which all the trees have been killed by fire or by the chestnut disease should be cut clean, the slash disposed of by burning and the land planted with conifers.

Plantations have been successfully started and are thriving to-day on all these types of planting sites.

Species:

Both conifers and broadleaf deciduous trees have found a place in past planting. The following list comprises those in private plantations of which the Station has secured a record. The arrangement is somewhat in accordance with their relative importance and the number planted.

Conifers

- White pine
- Red pine
- Scotch pine
- Norway spruce
- European larch
- Douglas fir
- Austrian pine
- Hemlock
- Balsam fir

Broadleaf Deciduous Trees

- White ash
- Sugar maple
- Oaks, red and black
- Tulip tree (whitewood)
- Catalpa
- Black locust
- Chestnut
- Oaks, white and swamp white

Broadly speaking, conifers should be chosen in preference to broadleaf species for forest planting in Connecticut. Natural woodland is chiefly composed of broadleaf deciduous trees, the so-called hardwoods, and under better management these forest areas will produce much useful timber of that kind. For the most part, lands requiring forest planting are poor in quality and better suited to growing conifers, such as pines, which require less from the soil than broadleaf trees. Conifers endure drought and maintain themselves on relatively dry, thin soils, or very sandy soils where hardwoods would be liable to fail. In yield, they exceed hardwoods in quantity per acre at the same age, and there will always be an excellent market for the material grown. Broadleaf trees may be selected, however, for planting on certain classes of sites for which they are specially adapted, or to produce hardwood material desired by the owner, or to use in mixture with conifers in planting.

Of the conifers, white, red and Scotch pines are to be preferred for commerical plantations; of the broadleaf trees, white ash, red oak, tulip-tree and sugar maple deserve consideration. In underplanting woodland it must be remembered that Scotch pine requires plenty of light for development, red pine can endure a little more shade, and white pine still more; good development depends, however, upon ample light and growing space. During the first ten years the rate of growth of white pine under medium shade of birch is one-half what it is in the open, according to experiments in the Rainbow plantations. White pine and red pine seem equally good species for Connecticut. They do well on a variety of soils and situations. On the better classes of soil, red pine equals or surpasses white pine in growth of the first ten years but on poor sandy soil it falls a little behind white pine. Red pine is not attacked by the pine weevil, which injures the leading shoot of white pine in some parts of the state. In case the weevil does considerable damage in a locality it may be better to choose red pine for planting or making a plantation of the two in equal mixtures. They are equally well adapted for growth together, or for growth in pure forest. Scotch pine should be confined to poorer, drier sites, especially sands. This species is the fastest growing of the pines and on dry, sandy soil has grown 10-16.5 feet in ten years from planting. On better classes of soils, Scotch pine is likely to grow so fast that the wood will be coarse and hence less valuable.

Norway spruce should be planted only on better classes of forest soils having fair moisture content, and not on low, wet, poorly drained soils. Such sites are frosty, and Norway spruce has proven susceptible to late frost injury. It is probably better adapted to the northern part of Connecticut than to the southern half.

Austrian pine is not specially recommended; other pines will furnish better products when grown.

Douglas fir, known also as Douglas spruce and Oregon pine, cannot yet be recommended with certainty. The hardy species from Rocky Mountain, and not from Pacific Coast seed, has made fair growth on medium quality soils, although not as rapid as white pine. On dry sandy soils its early growth is very slow, but after eight or nine years it begins to make greater annual height growth. This species is worth thorough trial, and is being experimented with at Rainbow.

Neither hemlock nor balsam fir are promising species for planting, as the wood of both is coarse-grained and of low value. Hemlock is also slow growing, and balsam fir short-lived. White ash and tulip tree are worth consideration for moist but not swampy sites, where the production of these two kinds of wood is desired.

Red oak, and possibly black (yellow) oak also, are useful in reforestation, but are not very fast growers. Plantations may be started from seed in spots or by setting seedlings. Sugar maple, being tolerant of shade, may be useful in mixture with other species and deserves more attention for the establishment of sugar groves in the state.

The planting of chestnut is not recommended until the probable outcome of the chestnut disease is known. Black locust is not recommended because of serious injury by the locust borer. Its ability to spread by seed and by root suckers makes it somewhat objectionable on the farm. White oaks are probably too slow in growth to be profitable for general planting.

A plantation of catalpa near Mystic on fairly good soil has done well in its early growth. This species is liable to winter-killing in most parts of the state, and is reported as doing poorly in Groton, Winchester and Windsor. A plantation, 27 years old, in the town of Fairfield has not made a valuable growth; the trees are not straight and well developed. Pine and larch have done much better in that locality. Most of the sites requiring reforestation are too poor in quality to develop catalpa well. Its final product, also, is not likely to be of much use excepting for posts and small poles, for which its durable wood is well suited.

Season of planting.

Early spring planting of conifers has proven, on the whole, better than fall planting, although there have been some successful instances of the latter. If fall planting is done it should be in the first half of September, so that the roots may have a little growth in their new place before winter. Fall planted stock is generally subject to some drying out; to injury by heavy wet snows since it has little root-hold on the soil; and to heaving out by frost action in the early spring. Broadleaf deciduous trees may be planted in the fall or in the spring, but there is less danger from gnawing animals if planted in the spring.

Spring planting is most successful when the work is started just as soon as the frost is well out of the ground, and the soil in condition to handle readily. Later, the heat tends to increase transpiration from the needles beyond the ability of the newly-set roots to furnish moisture, hence the plant simply dries out and dies. In one instance, late planting resulted in only a small per cent. of the trees being alive at the end of the season. Because it puts out its foliage so early, European larch should be planted very early in the spring or else in the fall. In an average season, the work of forest planting ought to be completed by the first week in May in order that the little trees may be benefited by the spring rains and become rooted before the new growth starts.

Size and Age of Trees for Forest Planting.

In general, one-year-old seedlings of broadleaf deciduous trees are sufficiently large for forest planting and their height varies according to species, etc., from six inches to twenty-four inches. Commercial nurseries often grade their stock according to height.

There are two classes of coniferous nursery stock for forest planting which may be distinguished: namely, seedlings and transplants. Seedlings are those trees grown from seed in beds or in drills until taken up and sent out for planting. Transplants are seedlings which have been transferred from seedbeds to nursery lines in order to develop more stocky tops and more vigorous, compact root systems. Seedlings of conifers used in forest planting are generally two years old, less frequently three years; transplants are three or four years old, more commonly three years. Seedlings are usually transplanted in the nursery when two years old and kept in nursery lines for one or two years. In all forest planting the trees should be young and have a small top and compact root system, with many fibrous roots, in place of long straggling ones. With the use of small trees the initial cost of planting is reduced and a larger per cent. survive. This principle has often been misunderstood in the past. Landowners have spent unnecessary money in establishing forest with trees three to six feet tall, and have not secured the advantage and success anticipated from the use of such large stock.

Two-year-old seedlings of white pine and red pine range from four inches to six inches in height. In years when abundant moisture was well distributed through the growing season, and on sites where competition of other growth was not severe, this size and age have been satisfactory. However, in seasons of drought, such as have been experienced in recent years, many failures in plantations have resulted from the use of two-year seedlings. Three-year-old transplants have generally done much better under such conditions. They range from five inches to eight inches in height and have a better root system as a result of transplanting. Four-year-old stock is larger, more costly, increases the labor and hence the cost of planting. This stock should be used only on sites where the plants have to meet strong competition or other special conditions, and as fillers for failed places in older plantations.

Two-year-old Scotch pine seedlings range from six inches to twelve inches in height and have strong roots. Trees of this age and size are suitable for planting and the use of transplanted Scotch pine is unnecessary in most cases. In one instance on a hot, dry, sandy site, there was heavy loss of two-year Scotch pines due to intense radiation of heat from the surface of the sand resulting in injury to the tender bark near the base. These trees had been grown too close together in the seedbed; they were slender and the bark tissues not thickened as in more open beds. Two-year transplants of Scotch pine are better suited for very dry, sandy sites.

Three or four-year-old transplants should be used when planting Norway spruce or Douglas fir. One-year or two-year-old seedlings are suitable for forest planting in the case of European larch.

The Source of Trees for Planting and their Care.

The Connecticut Agricultural Experiment Station has for a number of years furnished private owners with trees at cost for forest planting in the state, or procured them elsewhere for the same purpose. The table below gives the total number of trees distributed annually to private owners to stimulate forest planting. This was only a temporary policy, because suitable stock could not be procured otherwise during these years at reasonable prices by prospective forest planters. It will probably be given up after 1913 since private forest nursery companies will then be fully able to meet the demand with the right kind of stock and at fair prices.

TABLE III.

Distribution of Trees for Forest Planting.

Connecticut Agricultural Experiment Station.

Year.	Number of Trees.
1908	300,000
1909	300,000
1910	463,000
1911	302,000
1912	672,000
Total	2,037,000

Some of these trees were procured from Germany, but this practice was discontinued because the white pine blister rust was thus introduced. Since then the United States Secretary of Agriculture, under authority from Congress, has prohibited the importation of pines because of danger from disease and insects. In any event, stock grown in Connecticut or New England is to be preferred because of short distance and time required in shipment. Pines are usually shipped from the nursery in boxes containing bundles of fifty or one hundred trees each, and as soon as received the trees should be "heeled in" near the planting ground. After cutting the cord on a bundle so that plants may be separated, the roots should be dipped in water and the plants placed upright in a trench having one straight side, the earth being packed firmly around the roots. If soil next to the roots is watered occasionally, the trees may be kept in this manner for a week or more if necessary, when conditions are not right for immediate planting. They should be shaded with boughs or heeled in, in some shady place if planting is long delayed.

Number of Trees required per Acre.

The general rule for spacing trees in a forest plantation is to plant them sufficiently close so that they will crowd each other and develop tall, clean boles. This spacing must not be too close, however, or the trees will be so crowded as to stunt their growth, and the initial cost of the plantation will be increased considerably because of the greater number of trees used. According to species and conditions of site, the spacing varies from 4′ × 4′ to 6′ × 6′. Nearly all the plantations in Connecticut have been spaced 6′ × 6′; some, however, being 5′ × 5′, or 5′ × 6′. A spacing of 6′ × 6′, requiring 1,210 trees per acre, is best from the standpoint of economy and will produce good forest conditions as well as satisfactory development of individual trees. A wider spacing results in branchy trunks and lumber of poor quality. This effect of wider spacing has been demonstrated in plantations in Connecticut and elsewhere in New England.

On very brushy land, or on rocky sites, the full number per acre cannot be set, nor in planting poorly stocked cut-over land or in underplanting woodland. When such planting is undertaken advice should be sought from the forester of the Experiment Station, or from private foresters, to determine the density of planting and the subsequent cutting necessary to give underplanted trees proper development.

Preparation of the Site.

Usually preliminary preparation of the whole site is not possible, and it is neither necessary nor advisable. Furrows six feet apart in which to set trees are sometimes plowed on heavy sod land which is relatively level. Furrowing on slopes is a bad practice because there is great danger of surface water-flow washing out the soil and plants along the furrow. Furthermore, a planting site on a steep slope does not require such treatment since grass growth on it is usually light or interrupted.

Removal of brush renders planting easier and a little cheaper, but is expensive and generally not warranted by existing conditions. On the majority of sites, brush is not dense, or may be grubbed out at the spot where the tree is set. Although brush may somewhat hinder plants in growth at the outset by shading or crowding, yet it protects against late frost injury and tends to check evaporation from the soil. Treatment of such sites subsequent to planting will be discussed later on.

Methods of Planting.

Trees should be set at a slightly greater depth than they were in the nursery. Whatever the method, two essential things must be kept in mind by the foreman of the work: (1) that the roots should be protected at all times from drying out, either by carrying the trees in a pail containing water or in a basket with wet sphagnum moss; (2) that the trees should be firmly set in the soil without waste motions, yet with proper care. The mattock or grub hoe has proved to be the best tool.

The slit method has been practiced successfully on sites where there is little brush and a light grass growth, and where the soil is not hard. A square foot of sod is skinned off with a few strokes of the mattock. The blade is then struck down squarely into the ground to its full depth, the handle is raised and with the same motion twisted to one side slightly so as to open the ground at the edge and end of the mattock blade. Into this hole the tree is inserted in an upright position, the mattock then removed and the earth trodden firm with the foot. In this method an extra man or boy keeps from three to five planters supplied with trees as they need them, one tree at a time. A modification of this method, seen in practice on light soil, is to strike the mattock into the ground and, grasping the handle near the end, pull, thus opening a hole at the back of the blade. The tree is thrust to the proper depth into this hole, pressed to one side so as to straighten it up, the mattock removed and the earth firmed by the foot.

In some planting observed by the writer the grass was not scraped off from the spot where each tree was set. There was not a heavy sod, and trees similarly planted the year previous on adjoining land had sustained few losses in number. Removal of the sod is, however, recommended strongly by one authority,* and is probably a safer policy where competing grass, etc., may drain the moisture away from the tree roots or hinder access of water to the soil. Planting is rapid by the slit method. Care must be taken to put the tree at the right depth, to get the roots down into the hole and to leave the tree upright. If the work is not closely supervised, it tends to be careless. In one operation on a hilly site, careless planting under the modified method mentioned above left the trees nearly prostrate in position. The cause is evident: when the planters were working down hill, the tendency was to drive the mattock into the ground at an angle much less than the required right angle (i. e. perpendicular to the surface), the tree was thrust in, the ground tramped down and the tree inclined in each case down hill. Such planting was shallow, leaving the roots subject to drying out, and if the trees live, the lower part of the bole will be curved as it endeavors to assume an upright position. Heavy moist snowfalls will tend to further deform trees so planted.

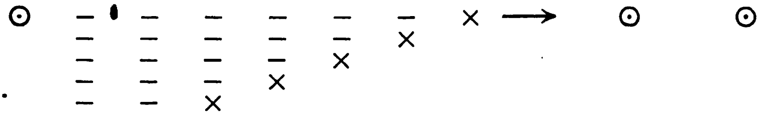
---

* Hawes and Hawley, Forestry in New England, 1912.

The hole method consists in digging a hole with a mattock after cleaning off a square foot of sod, and setting the tree in this hole. Pairs of laborers are engaged under this method. Those digging holes immediately precede those planting trees. Each planter may carry a pail containing a few inches of water in which the trees are placed upright, or two planters have such a pail between them. An extra laborer keeps the pails replenished. The practice of one laborer laying a tree in each hole in advance of those planting is condemned. It exposes the roots to drying out and under this practice trees are often left lying unplanted in the holes. It is better to have each laborer take a fresh tree from the pail as he needs it. In digging the holes, care must be taken not to scatter the earth, but leave it heaped up close to the hole. The size of the hole depends on the root system of the tree. Generally a hole five or six inches broad and deep is ample. Holes should not be made until just before the planter is ready to set the trees, because under usual conditions the soil in the hole dries out quickly and the roots will then be in contact with dry instead of fresh soil.

In planting, the laborer holds the tree in position at proper depth with his left hand, scoops a few handfuls of earth over the roots and presses it down on all sides with his hands. He then scrapes the rest of the soil into the hole with a few quick motions and tramps it firm with his feet. In doing this care has to be taken not to skin the bark off the stem, and to leave the tree upright in position. Firming the soil is essential to prevent leaving air spaces about the roots which will cause them to dry out and die. Careless planting is more likely to result thus with the hole method than with the slit method. Laborers are likely to grow careless toward the latter part of the day or fail to use care at all times unless closely supervised.

In the hole method, a fine-grained clayey soil will bake and evaporate moisture more or less rapidly. To avoid this the soil may be shredded roughly and spread, grass side down, around the plant. In lighter soils, such as sandy loam or sand, this is less essential. In the finer-grained soils capable of holding much moisture, there is danger of the plants being heaved out of the soil the spring of the second year, one year after planting. Such soils expand and contract much with alternate freezing and thawing in early spring. The slit method is preferable on sites of this character, since there is less danger of the soil heaving than there is when the soil has been loosened up in hole planting. In one plantation set by the hole method, large loss resulted from heaving of the trees. Regularity of planting is desirable in order to secure an even forest and uniform growing space for the trees. On rough Connecticut hillsides, regular spacing and exactly straight rows are an impossibility without great pains and additional cost, which is scarcely warranted. Distances need not be measured with exactness but careless spacing should be avoided. Laborers may be furnished six-foot rods or sticks to use until they learn to space the trees accurately. It is well to start on one straight side of the tract, if there is such, and work regularly back and forth. Stakes 5 or 6 feet tall should be set at the end of rows and one or two along the row. By these the laborers can line themselves in and keep the rows straight. If the first row is set straight, the other rows may be kept straight without setting stakes by lining with plants in adjoining planted rows. The following diagram illustrates this:



⟶ Planting Direction.
⊙ = Guide stakes.
× = Planters.
— = Trees planted.

Forest planting should be carefully supervised. If only four or five laborers are engaged in it, one may be put in charge if he is capable; he may plant and at the same time direct the work of the others. If many laborers are employed it is better to have one foreman who spends his time entirely in supervision.

Cost of Planting.

Mention has already been made (see p. 488) of the average cost of forest planting. Many factors have an influence on the cost; such as size and price of trees, conditions of planting site, spacing, price of labor, kind of labor and experience or inexperience in planting, nature of supervision, etc. Practically no information was given in reports of plantations as to these separate factors, the total cost figure being generally stated or the cost of trees and cost of setting them. Two-year seedlings have ranged from $2.50 to $3.50 per thousand in price in recent years, three-year transplants from $4.50 to $6.00 and four-year transplants $7.00 to $8.00 or more, per thousand. These prices are for conifers, none being available for the broadleaf trees planted. The latter would not ordinarily, however, exceed the prices given above. Close spacing increases cost, since more trees per acre are required. The price of labor does not vary to a great extent, but its quality is exceedingly variable. After a few days' experience two men, one digging holes and the other setting trees, can plant from 800 to 1,200 trees per day. If labor costs $1.75 per day, this would make the cost of planting the trees on a 6′ × 6′ spacing $3.50 to $5.25 per acre. Adding to this the cost of three-year-old transplants (figured at $5.50 per thousand) the cost of the planted trees per acre, exclusive of incidental expenses, would range from $10.10 to $11.85. With experienced labor and an open planting site this cost can be reduced somewhat. On more brushy sites it must inevitably be higher. If two-year-old seedlings are used, the cost is lowered by $2.50 to $3.00 per acre. Subsequent filling of failed places is liable to raise the net cost somewhat, however.

Planting under the slit method is faster and in many cases has been as successful as the hole method. On the basis of a 6′ × 6′ spacing, 1,200 trees to the acre, and the price per thousand $5.50 for three-year transplants, the average total cost of one extensive planting by this method was $9.29 per acre. In the case referred to, however, the average cost of 250,000 trees set in different years was $4.93, which would lower the average total cost to $8.61 per acre. The writer examined these plantations and some of them require partial replanting to make a complete stand. This would increase the total cost somewhat.

Careful planting is well worth while, but there cannot be the same care taken in planting or in preparation of the ground as is customary in ornamental or shade tree planting. In one series of large plantations in New Haven County in which some 300,000 trees have been planted, the work has been done painstakingly and what failures of plants occurred have been filled. Some land had to be cleaned of brush, etc., prior to planting, and the spacing was 5½ feet by 5½ feet, 1,440 trees to the acre. The total cost of trees, cleaning land, setting trees, some replanting and incidental expenses was $16.36 per acre. Replanting was found to be proportionately more expensive than the original planting. These plantations are in very good condition and probably the most nearly perfect of any in the state.

An owner in Litchfield County who has set 36,000 white pines, using his own farm labor, reports the total cost of trees, labor and incidental expenses as $8.00 per acre (spacing 5′ × 6′). The estimated per cent. alive is 75 to 80. He has not filled failed places. Such a low cost indicates the possibilities for planting by farmers at reasonable expense. In this case the low cost is due to intelligent personal supervision by the owner and the use of skilled farm labor. The land planted was open and grassy, with little brush, an average condition for open land planting. He reports that the men averaged more than one thousand trees each per day, an unusually large number. Planting done under contract has ranged in cost from $9.50 per acre (including cost of trees) to $16.25 per acre.

Losses and Replanting.

There are many causes of loss in forest planting. Death of trees may sometimes be traced to one or several of these, while in other instances it may be impossible to determine the cause. Some of the factors of loss can be controlled by the planter, such as planting poor stock in bad condition, allowing roots to dry out, careless planting, etc. Other factors, such as weather conditions, cannot be controlled. If, however, the former factors of loss are prevented, there is a much greater chance of success, even under adverse natural conditions following planting. Losses are most likely to occur during the first two years while the plants are establishing their root systems. Small slender trees with straggling roots, such as two-year white pine seedlings, suffer greater losses than stocky, well-rooted three-year-old transplants. The latter become established in their new site much more quickly, root deeper and are less subject to drought injury. This is upheld by observations of an owner in Litchfield County who has planted extensively on open land.

It is important that the trees be in good condition. Improper packing, long distance shipments, or unfavorable conditions in transit, may result in what is termed heated stock. Such trees have mouldy tops and even a scorched appearance, especially in the centers of bundles. In such cases the injured trees should be culled out or the shipment discarded and a new lot requested. There is relatively small danger of this trouble if stock is secured from nurseries in the state or near by. Trees should have a fresh, healthy appearance and the roots should be moist when received.

Care of the trees after arrival and until planted has been discussed (see p. 495). Conifers are very sensitive to the drying out of the fibrous roots. Subsequent losses will be heavy if the roots of the trees have been much exposed to sun and wind. Careless planting accounts for a great percentage of loss. In certain plantations the writer has traced whole rows where nearly every tree was dead, while adjoining rows showed scarcely one failure. It was evident that one laborer had been careless. This can be avoided by close supervision or better yet by discharging inefficient, careless laborers promptly on discovery. Careless planting may be detected by pulling on the plant after it is set to see that it is firm in the ground.

Planting early when the soil is fresh, the air cool, and the principal spring rains still to come, is most favorable to success. In later planting, losses are likely to occur, especially if a period of dry weather follows. Plantations on exposed sites, such as slopes with a south or southwest aspect, suffer severely from drought unless they have some protective vegetation, and heavy losses are likely to occur there. More trees die in plantations established on sod land than on poorer land with bunchy grass growth. In the former case, clearing away the sod where the tree is set will improve conditions. Several planters report a larger per cent. of the trees alive which were set on brushy land, in light birch growth, and on land "with some cover, not in grass, with some tall scattering trees," than on open sites.

Weather conditions are the greatest factor in success or failure in forest planting. The results in recent years have been very good considering the many unfavorable periods of long drought. A dry period in May and June is very hard on trees just set in forest plantations. A long summer drought in July and August is especially trying because of the great heat of these months. A fall drought finds the trees more fully established and does less damage. Abundance of rainfall is not so important as a moderate amount of moisture well distributed throughout the growing season.

A compilation from the reports on the plantations of data on cost of planting, number of trees planted and percentage of trees living, showed no relation between the cost and the resultant stand. In plantings of all grades of cost, there were successes as well as more or less complete failures. High cost does not necessarily indicate great painstaking in planting, nor does low cost, on the other hand, indicate hasty, careless work. The average of living trees for all plantations in which this item was reported is a little over 70 per cent. A relatively small number were below 50 per cent., and many were 75 to 85 per cent. successful. If losses are greater than 20 per cent., the blanks should be replanted the year following first planting. In those plantations having losses of 20 per cent. or less the blanks need not be filled unless they occur in groups which would result in wide gaps in the stand. The purpose of replanting is to secure a full future yield from the soil and proper development of merchantable timber of good quality.

Damage to Plantations—Protective Measures.

No protective measures can be taken against loss by drought. It is not practicable, because of the high cost, to water the trees if a dry period ensues either when planting them or subsequently. In experiments at Rainbow on a dry, hot, sandy site, Norway spruce and white pine suffered damage from intense heat of the sun's rays and drying out of the soil. The plants were a foot to two and a half feet tall, and had grown under considerable shade of gray birch and pitch pine, hence were tender. The injury was caused by complete removal of the overgrowth during August in an experiment to ascertain whether cutting in that season would check undesirable sprouting of birch.

Late spring frost sometimes injures the new growth of pine and spruce, the latter being considerably more susceptible to this injury. It does not occur on slopes where air drainage is good, but on more level sites where cold air collects and is stagnant. In the spring following the experiment mentioned above a late frost injured both species in numerous instances, but especially the spruce. The plot from which the birch growth was cleared was level and was surrounded on three sides by similar growth. It thus formed a sort of frost pocket, since air circulation was cut off by the adjoining growth. The needles of nursery transplants of pine are sometimes browned by winter injury, but this has not seemed to affect subsequent growth. Frost injury and drought injury sometimes produce a browning of the needles of older pines in plantations. The trees are weakened and some die, but loss has not generally been great in Connecticut from this cause. (See reports of Station Botanist for 1907 and 1909-10.) Only one case of frost injury to plantations of conifers was reported by private owners. This form of damage is not a prominent one. A light growth of brush, etc. may be of advantage on some planting sites since it affords protection from frost and winter injury. Catalpa has been reported to be winter killed in several localities.

Fire has destroyed small areas of planting in at least six instances, including one plot of an acre at Rainbow. The total area reported is about fifteen acres. Considering the total acreage planted, the loss is almost negligible. Coniferous plantations are especially susceptible to fire injury, and fire once started is difficult to stop. Two measures of prevention are suggested: (1) arousing of local interest in the plantation, its purpose and value; (2) an adequate system of fire lines. Both of these have combined to prevent serious damage by fire to the 100-acre tract of experimental planting by the Station at Rainbow in the town of Windsor. One fire started there on May 8, 1911, but was extinguished before it had covered more than an acre, the fire lines assisting greatly in stopping it.

Old roads through planted areas should be kept clear. In extensive plantations, cleared lanes bare of vegetation, dividing the area into smaller blocks, should be maintained if many causes of fire exist in the locality. Clearing inflammable material by burning along lines of danger, such as traveled roads, railroad lines, etc., will largely prevent danger from fire or prove of material assistance in checking fires. Posting of notices calling attention to the danger from fires and requesting coöperation in preventing them tends to educate local inhabitants and prevent fires. Non-resident owners should pay a small sum to some local person residing nearby to watch out for fires in especially dangerous seasons.

Animals cause damage in plantations. In hardwood plantations grazing animals will browse the young trees down to the ground. In coniferous plantations trees are not usually eaten, but the ground is packed and small trees are trampled and deformed. Plantations should not be grazed in early years and in later years the crown canopy shades the ground, killing the grass, hence grazing is out of the question at any time. In five plantations, grazing injury as described was reported. In one instance where feed was poor, cattle browsed the needles from young Scotch pines.

Rodents do some damage in plantations. Squirrels will eat planted chestnuts or white oak acorns, often securing a majority of the nuts planted. Tarring the nuts is suggested as a preventive measure. Rabbits gnaw the bark of locust trees in late winter and in one instance killed the greater part of such a planting. They also bite off the shoots of red oak and keep the trees eaten down to small bunches of sprouts. This injury occurred in red oak plantations on sandy land at Rainbow. Shooting and poisoning are possible remedies. Field mice may gnaw the stems of white pines causing considerable injury, but only one case of this kind was reported. Remedy in any such instances is poisoning the mice, but it is recommended that special advice be asked from the Station Staff before poisoning is undertaken since, carelessly used, it will result in death to the natural enemies of the mice as well.

Insects and fungi are important sources of damage. The chief ones are the white pine weevil and the chestnut bark disease. For detailed information on these subjects, application should be made to Dr. W. E. Britton, State Entomologist, and Dr. G. P. Clinton, Station Botanist, New Haven, Conn. Specimens should accompany the description of insects or fungous diseases injuring plantations.

The larvae of the white pine weevil mine in the terminal shoots and cause trees to become deformed by loss of their leaders. In June and July, top shoots turn brown when so affected and new growth wilts. The best measures to adopt are cutting off leading shoots below the injury and close to the next lower whorl of branches, burning these at once. If this is done early in July before the insect has emerged from the shoot in adult form, the numbers of the insect are materially reduced and the possibility of future damage is lessened. Serious damage has been done in plantations where no remedy has been applied. In 1911 weevil injury was reported from eighteen towns in plantations from five to ten years old.

Cleaning Plantations.

Pine plantations in which birch or other species have sprung up, and plantations set in brush or on cut-over land, require cleaning to prevent injury to the pines. Cleanings are usually made in stands from three to ten years old. Unless the interfering brush or small tree growth is cleaned out, many pines are killed by heavy shading, or are deformed by the competing worthless growth. The first cleaning should take place within two or three years after planting. One can give no definite rule as to the year, but must judge by the condition of the pines. There is no need of a painstaking costly removal of all growth other than the pines. In the first cleaning it is only necessary to go along the rows and to cut back to the ground with a bush hook or axe those bushes, sprouts and seedlings which directly interfere with the pines. Another cleaning may not be required but if within a few years the other growth again overtops the pines which grow slowly at the start, more work will be needed. In a second cleaning it will usually be unnecessary and of no advantage to cut the growth to the ground. It is better to cut it back so that it is below the tops of the pines. This will tend to check further sprouting and should also reduce the cost of the operation. Further cleaning will probably be unnecessary since the brush, etc. will then be crowded out rapidly by the pines.

Pruning.

Pruning of live branches is not recommended, since it reduces food producing foliage area. If the trees have been set at the proper distance apart, they will close together in two to twelve years and the lower branches will die for want of light. The dense shade also tends to conserve the moisture in the soil.

Subsequently the dead branches drop off, or may be cut and knocked off if the owners desire to undertake such expense in view of eventually producing clear saw timber. Considering the uses to which pine is usually put when cut, no material advantages come from trimming off dead branches.

Direct Seeding to Form a Forest.

Sowing or planting seed on the site where a forest is desired has been practiced to a small extent in Connecticut. In the case of conifers such as white pine, the seed may be broadcasted on unprepared or prepared ground at the rate of four or five pounds to the acre. Results are very uncertain and in experiments on sandy soil no trees were secured. The cost of seed and labor equals the cost of planting, while results in the latter case are much more sure. In Enfield, the Shakers started pine forests in this way on cultivated land some thirty years ago with success, but very large quantities of seed were used. Similar work to-day would be very costly and there are few sites susceptible of cultivation which will be put into pine. Partial seeding in prepared strips or in spots spaced 6′ × 6′ may be done at less cost, but experiments in this method with white pine have resulted in failure. Red oaks, chestnut and some other trees may be started from seed planted in spots on the site where forest is desired. The spots are prepared by scraping away the sod and after loosening the soil with a hoe or a mattock, two or three nuts or acorns are planted about an inch deep in the spot and the soil pressed down with the foot. A red oak plantation started in this way was entirely successful in one observed instance. Other plantings, especially of edible nuts, resulted in three-quarters loss. The nuts were given no protective treatment.

NOTE BY THE DIRECTOR.

Owing to the limits imposed by statute on the number of pages of the Station Report which may be printed at the State expense, an account of the other portions of the Station work done during the year cannot here be given.

Forester's office at Connecticut Agricultural Experiment Station.

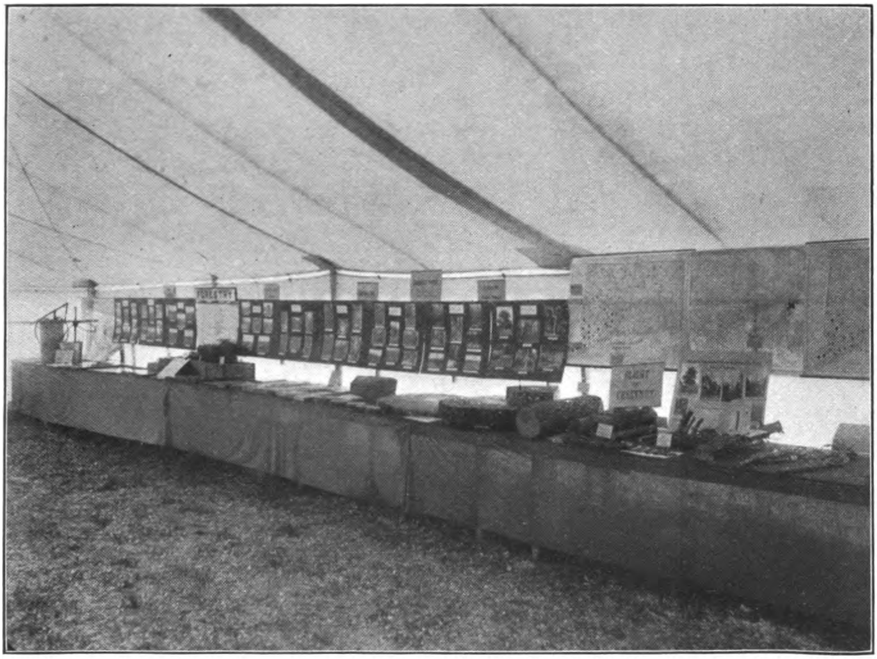
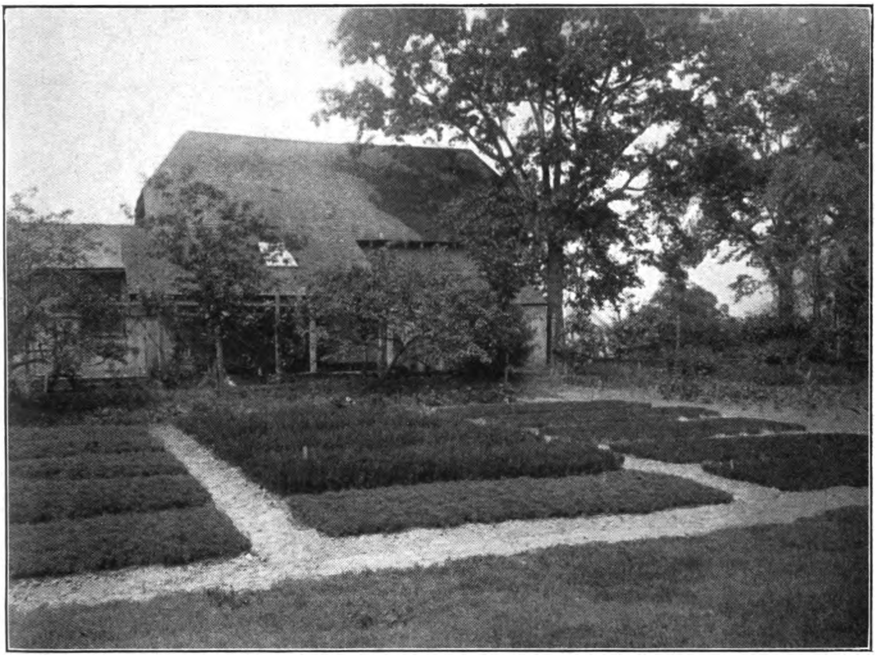
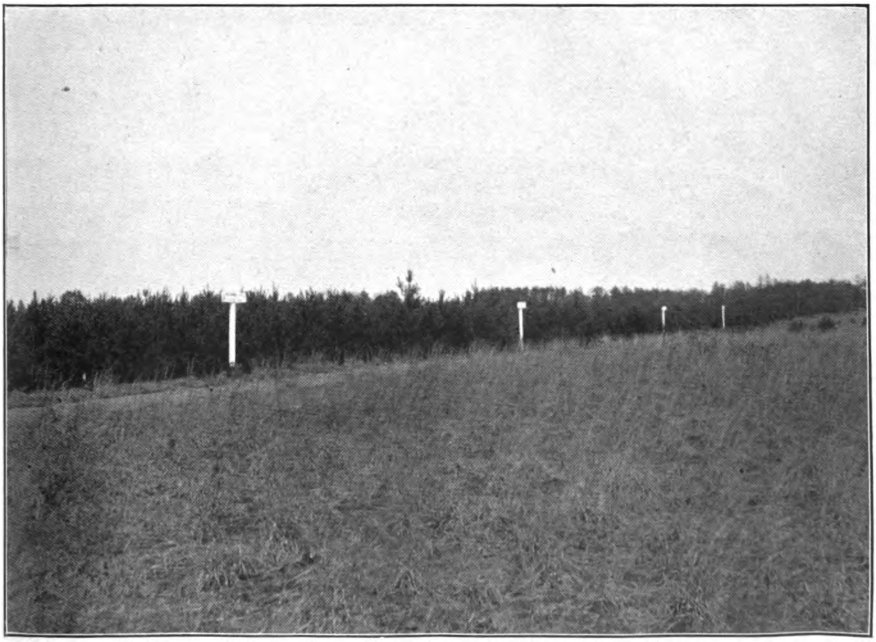


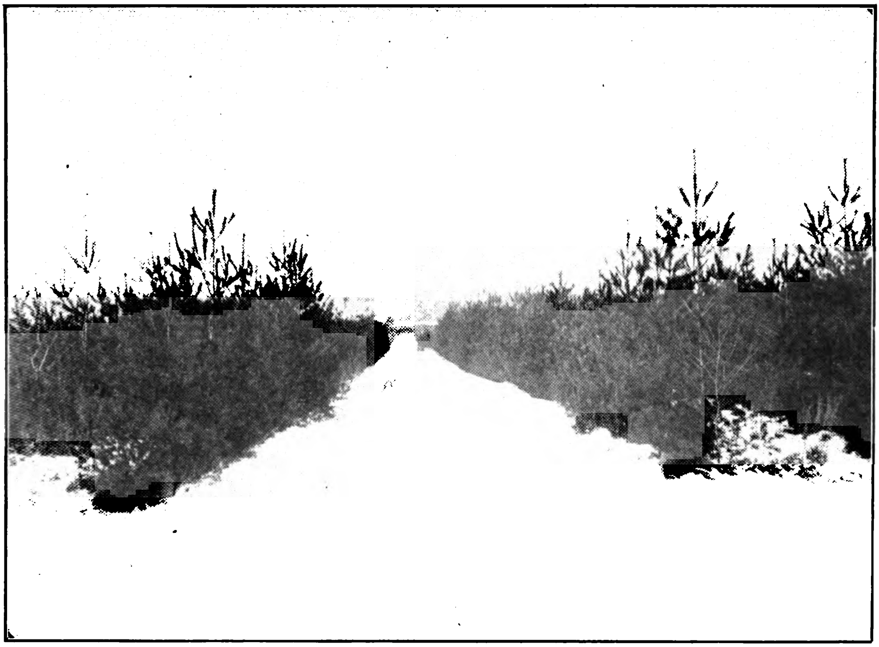
Exhibit of Forestry Department at Agricultural Fairs.



Seed-beds of white, Scotch and red pine on Station Grounds.

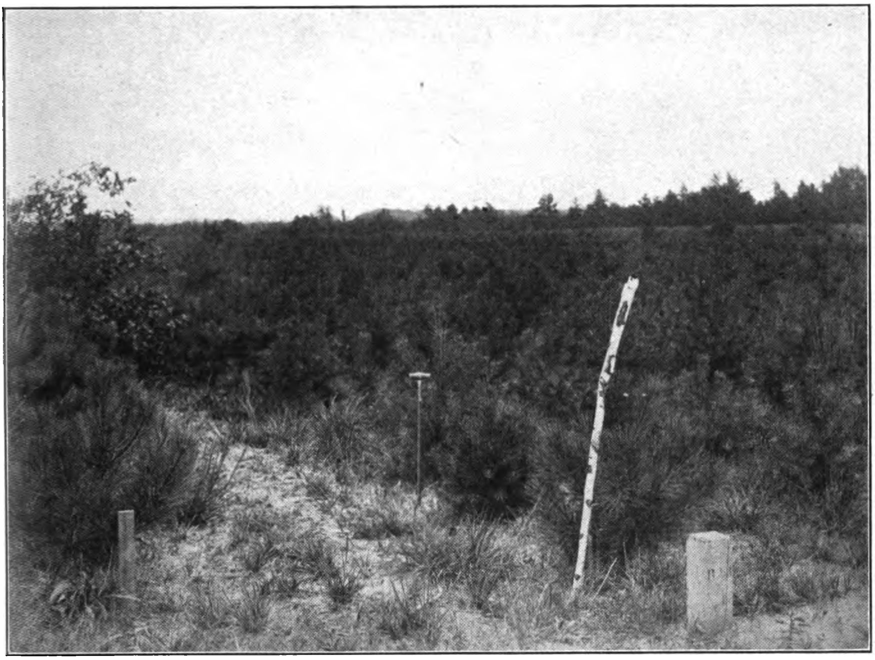


Pine plantations at Rainbow, plots 22–25.

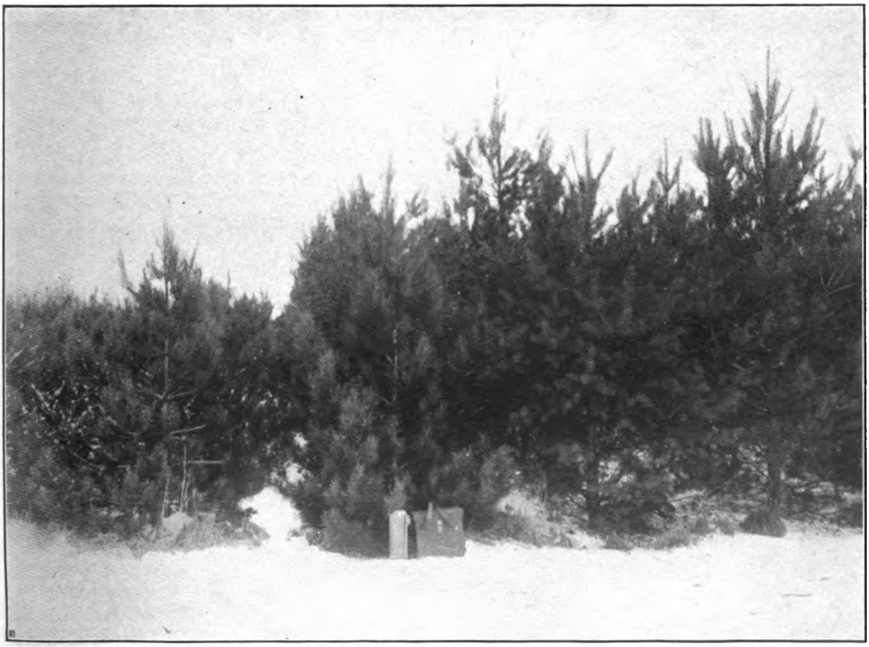


Fire lane between plots 60 and 68, Rainbow.

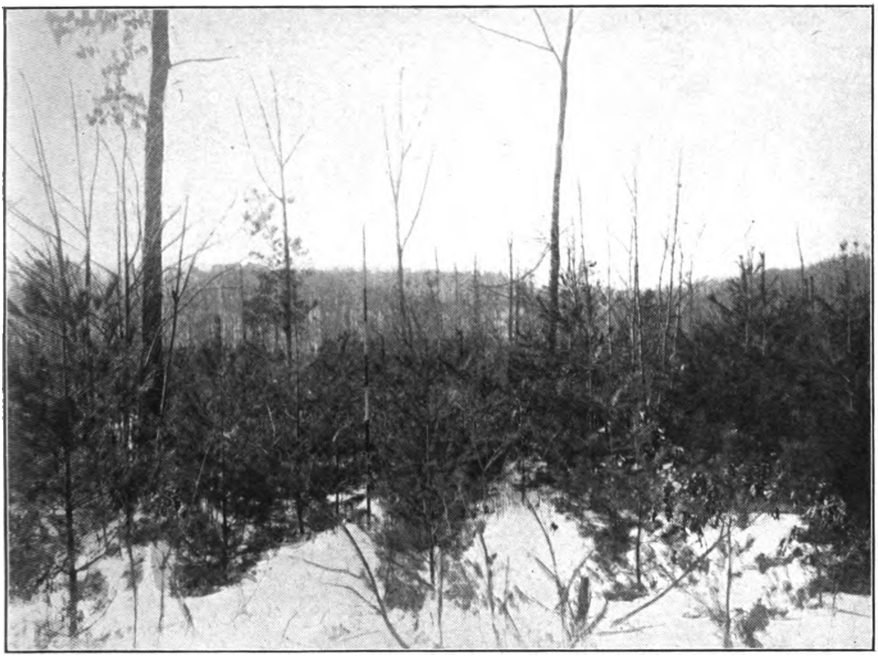
Interior of Scotch pine plantation, plot 23.



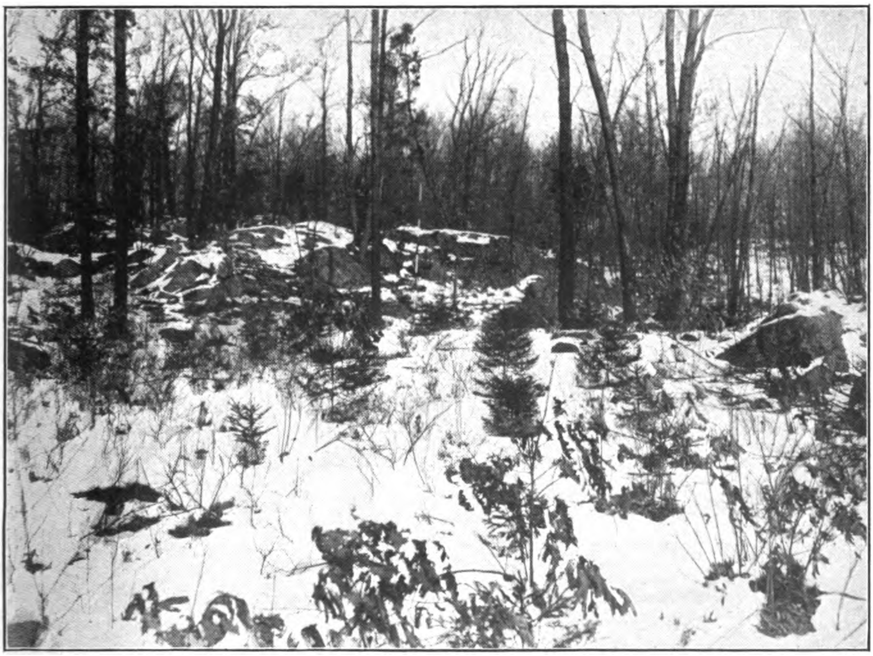
Red and Scotch pine on plots 22 and 23 in 1905.



Red and Scotch pine on plots 22 and 23 in 1912.



Eight-year-old white pine plantation on cut-over land.



Norway spruce under hardwoods nine years after planting.

INDEX.

Page

- Acetic acid 146, 204
- Acid phosphate 29
- Aconite 148
- *Acrobasis* 213
  - *caryæ* 253, 256, 257
- A. D. S. Rheumatic Remedy 195
- *Aecidium Fraxini* 343
- *Agelastica* (*Galeruca*) *alni* 292
- *Agrilus champlaini* 291
- Akoll Biscuit 109
- *Alabama argillacea* 217, 285
- Alfalfa feed 307
- *Alsophila pometaria* 216
- American Agricultural Chemical Co.:—
  - Complete Manure with 10% Potash 58
    - Tobacco Manure 48, 58
      - (Carb.) 49, 58
  - Grass & Lawn Top Dressing 58
  - H. G. Fertilizer with 10% Potash 58
    - Tobacco Manure 49, 58
  - Pulverized Sheep Manure 92
  - Tobacco Starter & Grower 58
  - Wheat & Haymaker 2
  - Bone Meal 42
  - Dry Ground Fish 36, 37
  - Fine Ground Bone 42
  - Grass & Oats Fertilizer 46
  - Ground Tankage 6 and 30 38, 40
  - Acid Phosphate 29, 30
  - Castor Pomace 25
  - Double Manure Salt 33
  - Genuine German Kainit 34
  - Ground Untreated Phosphate Rock 2
  - High Grade Dried Blood 2
    - Sulphate of Potash 33
  - Muriate of Potash 34
  - Nitrate of Soda 8, 9
  - Precipitated Bone 28
  - Thomas Phosphate Powder (Basic Slag) 27, 28
  - Bradley's Complete Manure for Potatoes & Vegetables 58
    - Top Dressing Grass & Grain 58
    - Corn Phosphate 58

Page

American Agricultural Chemical Co., *cont'd*:—
  Bradley's Eclipse Phosphate 58
    Farmer's New Method Fertilizer 58
    Niagara Phosphate 58
    Potato Fertilizer 58
      Manure 58
    X. L. Superphosphate 58
  Church's Fish & Potash 58
  Great Eastern General 60
    H. G. Vegetable, Vine & Tobacco Fertilizer 60
    Northern Corn Special 60
  North Western Fish, Bone & Potash 60
    Market Garden Phosphate 60
    10% Potato Fertilizer 60
    Universal Fertilizer 60
  Packers' Union Animal Corn Fertilizer 60
    Gardeners' Complete Manure 49, 60
    Potato Manure 60
  Quinnipiac Climax Phosphate 60
    Corn Manure 60
    Market Garden Manure 60
    Phosphate 60
    Potato Manure 60
      Phosphate 60
  Read's Practical Potato Special 60
    Standard Superphosphate 60
    Vegetable & Vine Fertilizer 60
  Wheeler's Corn Fertilizer 60
    Havana Tobacco Grower 60
    Potato Manure 60
    Grass & Oats 46
  Williams & Clark's Americus Ammoniated Bone Superphosphate 62
      Corn Phosphate 62
      H. G. Special Fertilizer... 62
      Potato Manure 62
    Potato Phosphate 62
Angusella 257
Anopheles 261, 269, 271
Anthracnose of banana 345
Apanteles laphygmæ 287
Aphid, potato 294
Aphis, green apple 215
  pine bark 217
  pomi 215
  sorbi (rosy apple) 215
Apiary inspection 223

Page

Apothecaries Hall Co.:—
    Basic Slag Phosphate 27, 28
    Nitrate of Soda 8, 9
Apple, orange rust of 344
Apples, dried 100
Apricots, dried 101
Arbor vitæ, Chinese 483, 490
Arena-Gluten Biscuit Mixture (Kellogg's) 110
Armour Fertilizer Works:—
    All Soluble 62
    Ammoniated Bone with Potash 62
    Bidwell's Formula for All Crops 49, 50, 62
    Bone, Blood & Potash 62
    Brewer's Special Tobacco Fertilizer 50, 62
    Complete Potato 62
    Corn King 62
    Fish & Potash 62
    Fruit and Root Crop Special 62
    High Grade Potato 62
    Market Garden 62
    Bone Meal 41, 42
Asafetida, powdered 150, 204
Ash, white 490
Ashes, substitutes for wood 90
    wood 90
Aspidiotus perniciosus 217
Bacterium tumefaciens 355, 358
Baker Castor Oil Co.:—
    Pure Castor Pomace 25
Banana, anthracnose of 345
Barker's Gluten Food 109
Basic slag 26
Bean vine meal 307
Beech, American 484
Beet pulp, dried 304, 328
        and molasses, dried 304, 330
Beetle, chrysomelid 292
    fiery ground 287
    gall-making 291
Berkshire Fertilizer Co.:—
    Berkshire Ammoniated Bone Phosphate 62
        Complete 62
        Grass Special 62
        Long Island Special 62
        Potato & Vegetable Phosphate 62
        Tobacco Special (Carb.) 62, 82
        Ground Bone 41, 42

Page

- Birch, black ... 484
  - gray ... 484
  - leaf skeletonizer ... 215
- Biscuit refuse ... 308
- Bitternut, walnut weevil on ... 247
- Black grass ... 265
- Blackberry sawfly ... 213, 236
- Blood, dried ... 10
- Blood tankage ... 10
- Board of Control, report of ... ix
- Boardman, F. E.:—
  - Boardman's Complete for Potatoes & General Crops ... 50, 62
- Bohl, Valentine:—
  - Self Recommending Fertilizer ... 41, 42
- Bone manures ... 41
- Botanist, report of ... 341
- Bowker Fertilizer Co.:—
  - Bowker's Complete Alkaline Tobacco Grower ... 64
    - (Carb.) ... 50, 64
    - Corn Phosphate ... 64
    - Early Potato Manure ... 64
    - Farm & Garden Phosphate ... 64
    - Fisherman's Brand Fish & Potash ... 64
    - Gloucester Fish & Potash ... 64
    - Hill & Drill Phosphate ... 64
    - Lawn & Garden Dressing ... 64
    - Market Garden Fertilizer ... 64
    - Potato & Vegetable Fertilizer ... 64
    - Special Crop Grower ... 64
    - Sure Crop Phosphate ... 64
    - Tobacco Starter ... 64
  - Stockbridge Special Complete Manure for Corn & All Grain Crops ... 64
    - Special Complete Manure for Potatoes & Vegetables ... 50, 64
    - Special Complete Manure for Seeding Down, Permanent Dressing & Legumes ... 64
    - Special Complete Manure for Tobacco ... 50, 64
    - Special Complete Manure for Top Dressing and for Forcing ... 64
  - Bowker's Dry Ground Fish ... 37
    - Fresh Ground Bone ... 42
    - Market Bone ... 42
    - Pure Unleached Canada Hardwood Ash ... 90, 91
    - Tobacco Ash Elements ... 64, 82
    - Acid Phosphate ... 29, 30
  - Muriate of Potash ... 34
  - Nitrate of Soda ... 8, 9

Page
Breakfast Toast (Kellogg's) 110
Brewers' grains, dried 304, 328
Brown-tail moth 216, 229
    control in 1912 229
        Brooklyn, Killingly 233
        Norwich 235
        Plainfield 234
        Pomfret, Putnam 232
        Sterling 233
        Stafford 234
        summary of 234
        Thompson 230
        Willimantic 234
        Woodstock 231
Brusson Diabetic Bread 109
Bucculatrix canadensisella 215
Buckwheat middlings 303, 328
Bud-moth, spruce 291
    walnut 213, 253
Buffalo Fertilizer Co.:—
    Buffalo Tobacco Producer 51, 64
    Celery & Potato Special 51, 66
    Farmers Choice 66
    Fish Guano 66
    High Grade Manure 66
    New England Special 66
    Top Dresser 51, 66
    Vegetable & Potato 66
    Bone Meal 42
Bumble flower beetle 216
Butter 205
    and butter substitutes 201
Butternut, walnut weevil on 243
Cabbage, black bacterial rot of 345
    butterfly, common southern 293
Calopactis singularis 418
Calosoma calidum 287
Candy. 202
Canker, pine stem 354
    stem, of peach 351
Canned goods, relative amounts of solids and liquor in 137
Carya porcina 257
Castor pomace 13
Catalpa 490
Cedar apple 343
Celery 206

Page

Central Phosphate Co.:—
    Tennessee Phosphate Rock 25, 26
Chermes pinicorticis 217
Chestnut 484, 490
    bark disease
        American species of Endothia 417
            Endothia gyrosa 422–425
                gyrosa var. *parasitica* 425–427
                radicalis 418–422
        artificial cultures 428, 438
        characteristics of the disease 364
        damage and loss already caused 378
        discussion of effects of 468
        distribution and hosts 370
        general summary 452
        historical consideration 359
        inoculation experiments 434
        literature 449
        native home of the fungus 413
        present situation and future prospects in Connecticut 380
        preventive experiments 442
        previous chestnut troubles 407
        recommendations for Connecticut 447
        relation to condition of host 389
Chionaspis furfura 217
Chittenden, The E. D., Co.:—
    Chittenden's Complete Tobacco & Onion Grower 66
        Connecticut Tobacco Grower 52, 66
        Grain & Vegetable 66
        Grass & Grain 66
        Potato & Grain 66
            Manure 66
        Special Formulae Fish & Potash 66
        Tobacco Special 66
Chop feeds 305, 330
Chrysomelid beetle 292
Cider 206
Cimbex americana 294
Cinnamon 202
Citrate of magnesia 205
Clark, The Everett B., Seed Co.:—
    Clark's Special Mixture 66
        10% 66
Cocoa 202
Coe-Mortimer Co.:—
    E. Frank Coe's Celebrated Special Potato 66
        Compete Manure with 10% Potash 53, 66

Page

Coe-Mortimer Co., *cont'd:—*
    E. Frank Coe's Gold Brand Excelsior Guano 66
        H. G. Ammoniated Bone Superphosphate.. 66
        New Englander Corn & Potato 66
        Red Brand Excelsior Guano 68
        Tobacco & Onion Fertilizer 68
    Peruvian Tobacco Fertilizer 53, 66
        Vegetable Grower 53, 66
    Dry Ground Fish 36, 37
    XXX Fine Ground Bone 42
    E. Frank Coe's H. G. Soluble Phosphate 29, 30
    Muriate of Potash 34
    Nitrate of Soda 8, 9
    Sulphate of Potash 33
    Thomas Phosphate Powder (Basic Slag Meal) 26, 27, 28
Coleosporium Solidaginis 353
Commercial feeding stuffs, law concerning 297
Connecticut Valley Orchard Co.:—
    C. V. O. Co.'s Complete High Grade Fertilizer 68
Conotrachelus juglandis 213, 240, 241, 242, 243, 246, 247, 254
    nenuphar 245, 246, 247
Contents, table of v
Cooper's Fertilizer, Peter:—
    Cooper's Bone Dust 42
Corn and oat feeds 305, 330
    bran 302
    canned 96
    cob mixed with wheat feed 305, 330
        with hominy feed 302
    Kaffir, grain smut on 351
    oats and barley 304, 330
Cotton hull ashes 35
    moth 217
    seed meal 10
        for feed 298, 318
    worm 285
Cream 203, 205
Cronartium Comptoniae 354
    ribicola 347
Crown gall on rose 355
    on wistaria 358
Cubanos 192
Culex canadensis 280
    cantator 259, 260, 269, 278
    pipiens 217, 267, 269, 282
    sollicitans 217, 259, 261, 269
Currant, rust of black 347

Page
Currants, dried 103
Cut-worms 216
Cylindrosporium Pomi 354
Dairy and Food Commissioner, samples examined for 201
stock feeds, proprietary 306, 332
Dampening-off of evergreens 348
Datana ministra 216
Dates, dried 105
Diaporthe parasitica 360, 452
Digestibility of feeding stuffs 309
Dissolved rock phosphate 29
Distichlis maritima 265
Distillers' grains, dried 304, 328
Double manure salt 31
Drainage work, mosquito 283
Dried fruits 97
Drug products 146
Eldredge, T. H.:—
Eldredge's Special Fish & Potash Fertilizer 68
Superphosphate 68
Elm leaf beetle 216
saw-fly 294
Ely's Liquid Cream Balm 192
Endothia gyrosa 422–425, 453
var. *parasitica* 359, 425–427, 453
longirostrata 417
Parryi 417
radicalis 418–422, 453
English ivy, imported from Europe, a chrysomalid beetle on 292
Entomological department expenditures 209
publications of 210
summary of inspection and office work 214
features 214
Entomologist, report of 209
Errata xx
Essex Fertilizer Co.:—
Essex Complete Manure for Corn, Grain & Grass 68
for Potatoes, Roots & Vegetables 68
Market Garden & Potato Manure 68
Special Tobacco Manure 68
Tobacco Starter & Grower 68
XXX Fish & Potash 68
Ground Bone 42
Eulecanium tulipiferæ 295
Euphoria inda 216
Euplectrus comstockii 287
Euproctis chrysorrhœa 216, 229

Page
Euvanessa antiopa 216
Evergreens, dampening-off of 348
  sun scorch of 349
Examination of food and drug products, summary of 208
Exorista pyste 258
Fall army worm 215, 284
  control measures 287
  description, life history 285
  natural enemies 286
  outbreak of 284
  canker worm 216
Feeding stuffs, average composition, digestibility and price of 310, 312
  digestibility of 309
  report on commercial 297
Feeds, analyses of 318
  cost of 316
  definitions of 338
  manurial ingredients of 313
Fertilizer elements, trade values of 6
  law, observance of 1
Fertilizer Materials Supply Co.:—
  No. 1 Potato & General Truck Fertilizer 53, 68
  Basic Slag 27, 28
  Nitrate of Soda 8, 9
  Acid Phosphate 29, 30
  Muriate of Potash 30
  Steamed Bone 42
Fertilizers, explanations concerning analyses 3
  report on 1
  sampling and collection of 1
  valuation of 3
Fiery ground beetle 287
Figs, dried 107
  Syrup of 153
Fir, balsam 484
  red 484, 490
Fire, damage to forest caused by 467
Fish manures 36
Food products, report on 96
Forest fire warden, duties of 456
  fires 457
  plantations at Rainbow, description of 471
    cleaning 506
    pruning 506
  planting, cost of 499
    in Connecticut 485
      prior to 1912, summary of 486

Page

Forest planting, *cont'd*:—
        information and instructions regarding 488
        losses and replanting 501
        method of 496
        number of trees per acre 495
        planting sites 488
        preparation of site 496
        protection from damage 503
        season of 492
        size and age of trees for 493
        source of trees for 494
        species for 490
    Portland State 463
    seeding 507
    Simsbury State 465
    Union State 465
Forester, duties of State 455
    report of State 455
    Station 466
Forests, State 463
Franck's Grains of Health 187
Frisbie, L. T., Co.:—
    Frisbie's Connecticut Special 53, 54, 68
        Corn & Grain Fertilizer 53, 68
        Potato Manure 68
        Top Dressing 68
        Vegetable Grower 68
        Fine Bone Meal 42
        Ground Tankage 38
    Acid Phosphate 29, 30
    Muriate of Potash 34
    Nitrate of Soda 8, 9
Frontina frenchii 286
Fruit spot of quince 354
    syrups 206
Fruits, dried 97
Galerucella luteola 216
Gall-making beetle 291
Garden millipede or "thousand legs" 295
German Kali Works:—
    Kainit 34
    Muriate of Potash 32, 34
    Sulphate of Potash 33
Gloeosporium Musae 345
    musarum 345
Gluten Biscuit (Kellogg's) 40% 110
    80% 110

Page

Gluten feed ... 301, 324
  foods ... 107
  meal ... 301
Gluten Meal (Kellogg's) 20% ... 109
  40% ... 109
  80% ... 109
Glycerine ... 157
Gouraud Oriental Cream ... 185
Gymnosporangium effusum ... 350
  japonicum ... 350
  macropus ... 343
Gypsy moth, control work ... 216, 224
  Stonington infestation ... 224
  Wallingford infestation ... 225
  scouting for, in Canaan ... 229
    Norfolk, North Canaan ... 228
    Salisbury ... 227
    Sharon ... 229
Hedera helix ... 292
Heliophila unipuncta ... 285
Hemerocampa leucostigma ... 216
Hemlock ... 490
Hen manure ... 90
Heroin ... 158
Hicoria alba ... 247
  laciniosa ... 253
  minima ... 247
  ovata ... 247, 253
  pecan ... 254
  porcina ... 257
Home mixtures ... 84
Hominy feed ... 302, 326
  and corn cob ... 302
Honey ... 110
  methods of analysis of ... 113
Hop hornbeam, gall-making beetle on ... 291
Hops, powdery mildew of ... 349
Horse feeds, proprietary ... 305, 332
Hydrozone ... 184
Ice cream ... 203, 206
Insect notes, miscellaneous ... 291
Inspection, apiaries ... 223
  imported stock ... 220
  nurseries ... 217
  summary of ... 214
Ironwood, gall-making beetle on ... 291

Page

James, Ernest L:—
  James' Ground Bone 42
Juglans australis 253
  californica 253
  cinerea 243, 247
  cordiformis 243, 244, 247, 253, 254
  mandshurica 247, 253
  nigra 244, 247, 253
  regia 243, 244, 247, 253, 254
  rupestris 253
  sieboldiana 243, 244, 247, 253
Julus hortensis 295
Juncus gerardi 265
Juniper, rust of Chinese 350
  web worm 295
Kainit 32
"Kanona" 40
Kargon Compound 188
Lachnosterna: crenulata, fraterna, fusca, hirticula, nova 289
Laphygma frugiperda 215, 284
Larch, European 484, 490
Lecanium 295
Lemon extract 203, 206
Leopard moth 216
Lepidosaphes ulmi 217
Lime, burned or quick 89
  shell marl 90
  slaked 89
Limestone 86
Limneria dubitata 287
Linseed meal 25, 299, 318
Lister's Agricultural Chemical Works:—
  Lister's Ammoniated Dissolved Bone Phosphate 70
    Complete Tobacco Manure 70
      (Carb.) 70
    Corn & Potato Fertilizer 70
    Potato Manure 70
    Special Grass Mixture 70
      10% Fertilizer 2, 54, 70
    Standard Pure Bone Superphosphate of Lime 70
    Success Fertilizer 70
    3-6-10 for Potatoes 70
    Celebrated Ground Bone & Tankage Acidulated ... 41
Locust, black 484, 490
Macrodactylus subspinosus 216
Macrosiphum (Nectarophora) solanifolii 294

Page
Magnesium carbonate 159
citrate 205
methods of analysis of 165
solution of 160
Malt Carbonic 207
sprouts 303, 328
Manchester, E., & Sons:—
Manchester's "Formula" 54, 70
"Helper" 70
"Special" 54, 70
Muriate of Potash 33
Manure, hen 91
sheep 92
Mapes F. & P. G. Co.:—
Average Soil Complete Manure 70
Cereal Brand 70
Complete Manure "A" Brand 70
Corn Manure 70
Economical Potato Manure 70
Fruit & Vine Manure 70
Potato Manure 70
Seeding Down Manure 72
Tobacco Ash Constituents 72
Manure, Wrapper Brand 54, 72
Starter, Improved 72
Top Dresser Improved, Full Strength 72
Half Strength 72
Vegetable or Complete Manure for Light Soils 72
Dissolved Bone 70
Maple sugar 490
Mildew of hops, powdery 349
Milk 203, 205
Mites: on ash tree, on chrysanthemums 296
Mixed feed 301, 322
Mockernut, walnut weevil on 247
Molasses 203
with shredded twigs 307
Morphine in paregoric, method of determination of 168
Mosquito: banded salt marsh, brown salt marsh 259, 269
malarial 261, 269
rain barrel or house 217, 269
control 263
work 1912 270
Branford 277
corporations interested 277
Darien 272
draining 273

Page

Mosquito control work, *cont'd*:—
      Fairfield 272
      fresh water breeding places 280
      future work around New Haven 276
      Greenwich 270
      Guilford 279
      legislation needed 268, 283
      New Haven and vicinity 272
      oiling of breeding pools 266, 275
      Old Saybrook and Old Lyme 279
      screening of rain water receptacles 267
      South Norwalk 272
      Stamford 271
      summary 269
   plague, how to control 259
Munroe, Geo. L., & Sons:—
  Pure Unleached Wood Ashes 2, 90, 91
Myxosporium Musae 345
National Fertilizer Co.:—
  National Ammoniated Bone Phosphate 72
    Complete Grass Fertilizer 55, 72
      Root & Grain Fertilizer 72
      Tobacco Fertilizer 72
    Eureka Potato Fertilizer 54, 72
    Fish & Potash 72
    Formula "A" 72
    High Grade Top Dressing 2
    Market Garden Fertilizer 72
    Potato Phosphate 72
    XXX Fish & Potash 72
    Tobacco Special 72
      (Carb.) 72
Natural Guano Co.:—
  Sheep's Head Brand of Pulverized Sheep Manure 92
"Near beer" 206
New England Fertilizer Co.:—
  Corn & Grain Fertilizer 74
    Phosphate 74
  High Grade Potato Fertilizer 74
  Perfect Tobacco Grower 74
  Potato Fertilizer 74
    Grower 74
  Superphosphate 74
  Ground Bone 42
  Tankage 38

Page
Niantic Menhaden Oil & Guano Co.:—
  Bone, Fish & Potash 74
  Corn & Grain 74
  High Grade Tobacco 74
  Market Garden 74
  Potato & Vegetable 74
  Acidulated Fish 37
  Dry Ground Fish 37
  Sheepino Natural Guano 92
Nitrate Agencies Co.:—
  Ground Bone 41, 42
  High Grade Acid Phosphate 29, 30
  Muriate of Potash 34
  Nitrate of Soda 8, 9
  Sulphate of Potash 33
  Basic Phosphate 27, 28
Nitrate of soda 8
Nitrogen, solubility of the organic 48
  of raw materials, cost of 44
Nitrogenous superphosphates 47
  regarding guaranties of 57
  valuation of 82
Nursery firms receiving certificates in 1912, list of 218
Oak, red 484, 490
  white 484, 490
Oats 303
Oiling mosquito breeding pools 266, 275
Olds & Whipple:—
  O. & W. Complete Tobacco Fertilizer 74
    Corn & Potato 74
    Fish & Potash 74
    Grass Fertilizer 74
    High Grade Potato Fertilizer 74
    Special Phosphate 74
    Dry Ground Fish 37
    Vegetable Ash & Bone 55, 74
    Grey Pomace 25
    Precipitated Bone 28
    Vegetable Potash 34
  Ross Brothers' Thomas Slag 27, 28
Opium 166
Ostrya virginica 291
Oyster shell scale 217
Oysters 206
Package goods, cost of 138
  net weight of 137, 205

Page
Pamphilius dentatus 213, 236, 237, 239
persicum 238, 239
Paregoric 166
Parmenter & Polsey Fertilizer Co.:—
P. & P. Grain Grower 74
Plymouth Rock Brand 74
Potato Fertilizer 74
Grower 74
Special Tobacco Grower 74
Peach, constriction disease of stem 351
stem blight of 351
canker of 351
Peanut meal 299
Percentage difference 7
Peridermium acicolum 352
delicatulum 352
pyriforme 354
Strobi 347
Peruna 194
Peziza cinnabarina 421
Phalonia rutilana 295
Phanerotoma tibialis 258
Phenacoccus acericola 217
Phoma brassicae 357
Napobrassicae 355
oleracea 357
Persicae 351
pithya 354
Phosphate rock, ground 25
Phosphoric acid of raw materials, cost of 44
Pierce's Golden Medical Discovery 193
Pine, Austrian 482, 490
bull 482
Corsican 482
Jack 482
Japanese black 483
red 483
mountain 483
Norway 483
pitch 483
red (Norway) 483, 490
Scotch 483, 490
stem canker 354
western yellow 483
white 483, 490
bark aphis 217
Pine-currant rust 347

Page
Pine-Solidago Rust 352
Pine-sweet-fern rust 354
Pinex 199
Pissodes strobi 213
Plant diseases of Connecticut, notes on 341
    or hosts not previously reported 344
    prevalent in 1911 and 1912 341
  food in raw materials, cost of 44
Platt, The Frank S., Co.:—
  Platco Market Garden Phosphate 74
Plum curculio 245, 246, 247
Poisoning, cases of 207
Pontia (Pieris) protodice, rapæ 293
Porthetria dispar 216
Poslam 186
Potash, high-grade sulphate of 31
  low-grade " " 31
  muriate of 32
  vegetable 35
  of raw materials, cost of 45
Potato aphid 294
Poultry feeds, proprietary 306, 334
Precipitated bone 28
Proprietary remedies 184
Prunes, dried 107
Pseudomonas campestris 345
Pulverized Manure Co.:—
  Wizard Brand Manure ..... xx, 92
Quince, fruit spot of 354
Rain water receptacles, screening of 267
Raisins 107
Red Dog Flour 301, 324
Red-humped caterpillar 216
Report of board of control lx
    botanist 341
    entomologist 209
    forester 455
    treasurer xvii
  on commercial feeding stuffs 297
  fertilizers 2
  food products 96
Rheumatogen 196
Rhizoctonia sp. 348
Rice 118, 204
Roestelia aurantiaca 344
    koreaensis 350

Page

- Rogers & Hubbard Co.:—
  - Hubbard's "Bone Base" Complete Phosphate 76
    - Fruit or Grass & Grain Fertilizer.. 76
    - New Market Garden Phosphate .. 76
    - Oats & Top Dressing 76
    - Potato Phosphate 76
    - Soluble Corn & General Crops Manure 76
    - Soluble Potato Manure 76
      - Tobacco Manure 55, 76
    - Pure Raw Knuckle Bone Flour .. 41, 42
    - Strictly Pure Fine Bone 41, 42
- Rogers Mfg. Co.:—
  - All Round Fertilizer 76
  - Carbonate Formula for Tobacco 56, 76
  - Complete Potato & Vegetable 76
  - Fish & Potash 76
  - High Grade Complete Corn & Onion 76
    - Fertilizer for Oats & Top Dressing 76, 82
    - Grass & Grain for Seeding Down 76
    - Soluble Tobacco 76, 82
    - Tobacco & Potato 76
      - Grower 76
  - Tobacco Grower, Vegetable & Carbonate Formula 76
  - Pure Fine Ground Bone 42
    - Knuckle Bone Flour 42
  - High Grade Sulphate of Potash 33
  - Muriate of Potash 34
  - Nitrate of Soda 8, 9
- Rose chafer 216
  - crown gall on 355
- Ross Brothers, *see* Olds & Whipple.
- Rosy apple aphis 215
- Rot, of cabbage, black bacterial 345
  - of Swede turnip, phoma 355
- Royster, F. S., Guano Co.:—
  - Royster's Ammoniated Potato Manure 76
    - Champion Crop Compound 76
    - Fish & Potash 76
    - Garden & Truck Guano 76
    - General Crop Fertilizer 76
    - High Grade Tobacco Manure 56, 78
    - Ideal Tobacco Guano 78
    - Universal Truck Fertilizer 78
    - Fine Ground Bone Meal 42
    - Tobacco Ash Components 56, 78
  - Nitrate of Soda 8, 9

Page

Royster, F. S., Guano Co., *cont'd*:—
  Royster's High Grade 16% Acid Phosphate 29, 30
  Sulphate of Potash 33
Rust, apple 343
  orange, of apple 344
  Chinese juniper 350
  pine-currant 347
  pine-Solidago 352
  pine-sweet-fern 354
  white ash 343
Rye products 303, 326
Salt marsh, area in Connecticut 261
    condition of 262
    method of draining 263
    mosquitoes 217, 259, 269
    results of draining, cost 265
San José scale 217
Sanatogen 197
Sanderson Fertilizer & Chemical Co.:—
  Kelsey's Bone, Fish & Potash 78
  Sanderson's Atlantic Coast Bone, Fish & Potash 78
      Complete Tobacco Manure 78
      Corn Superphosphate 78
      Formula A 78
        B 78
      Potato Manure 78
      Special with 10% Potash 78
      Top Dressing for Grass & Grain 78, 82
      Blood, Bone & Meat 10
      Fine Ground Bone 42
        Fish 37
      Double Manure Salt 33
      Kainit 34
      High Grade Sulphate of Potash 33
      Muriate of Potash 32, 34
      Nitrate of Soda 9
      Plain Superphosphate 29, 30
      Thomas Phosphate Powder 27, 28
      Tankage 38, 40
Sausage 122, 204
    method of determining starch in 122
Sawfly, blackberry 213, 236
    description of 238
    elm 294
    habits, life history 237
Schenck's Pulmonic Syrup 190
Schizura concinna 216

Page

- Scurfy scale, 217
- Shay, C. M., Fertilizer Co.:—
  - Shay's Corn Fertilizer, 78, 82
    - Grass Fertilizer, 56, 78
    - Potato Manure, 56, 78, 82
    - Ground Bone, 42
    - Fish Tankage, 37
    - Tankage, 38
    - Special, 82
- Sheep manure, 92
- Shell marl lime, 90
- Shellbark hickory, 247
- Shoemaker, M. L., & Co.:—
  - "Swift-Sure" Superphosphate for General Use, 78
    - for Potatoes, 57, 78
    - for Truck, Corn & Onions, 78
    - Bone Meal, 42
- Smut, on Kaffir corn, grain, 351
- Sodium salicylate, 169
- Soy Bean Gruel Flour, 109
- Spaghetti, 206
- *Sphacelotheca Sorghi*, 351
- *Sphaeria fluens*, 424
  - *gyrosa*, 363, 417, 421, 423, 424
  - *radicalis*, 419, 420, 421, 424
- *Sphaerotheca Humuli*, 349
- Spike grass, 265
- Spiny elm caterpillar, 216
- Spiro Powder, 185
- Spruce, Douglas, 484, 490, 491
  - Norway, 484, 490, 491
  - bud-moth, 291
- Starch in meat products, methods of determining, 122
- Station, officers and staff of, iii
- Strawberry crown borer, 295
- Sulphur, precipitated, 170, 205
- Sun scorch of evergreens, 349
- Superphosphates, nitrogenous, 47
- Swift's Lowell Fertilizer Co.:—
  - Swift's Lowell Animal Brand, 80
    - Bone Fertilizer, 80
    - Corn & Vegetable Manure, 80
    - Empress Brand, 80
    - Market Garden Manure, 57, 80
    - Perfect Tobacco Grower, 80
    - Potato Grower, 57, 80
      - Manure, 80

Page

Swift's Lowell Fertilizer Co., *cont'd:*—
  Swift's Lowell Potato Phosphate 57, 80
    Special Grass Mixture 57, 80
      Potato Fertilizer 57, 80
    Superior Fertilizer 57, 80
    Tobacco Manure 80
    Ground Bone 42
    Tankage 2
  Muriate of Potash 2
  Nitrate of Soda 2
Table of contents v
Tachinid flies 258, 286
Tankage, blood 10
  egg 40
  slaughterhouse 36
Tanner & Wilcox:—
  Grass & Corn Phosphate 80
  Reliable Potato & Garden Phosphate 57, 80
Tannic acid, relation to chestnut blight 404
Tarsonemus pallidus 296
Tetranychus bimaculatus 296
Thialion 191
Thomas phosphate 26
Tobacco siftings 92
Tolype velleda 293
Tomatoes, canned 125
Tortrix fumiferana 291
Toumeyella liriodendri 217, 294
Treasurer, report of xvii
True army worm 285
Tulip tree 490
  scale 217, 294
Turnip, phoma rot of Swede 355
Turpentine 172, 205
Twigs and molasses 307
Tyloderma fragariæ 295
Valsonectria parasitica 363
Valuation of bone and tankage, method of 7
  fertilizers 3
  mixed fertilizers, method of 7
  nitrogenous superphosphates 82
Van Iderstine Co.:—
  Van Iderstine's Pure Ground Bone 42
Vinegar 207
Walnut bud-moth 253
  description 256
  habits and life history 254

PAGE
Walnut bud-moth, *cont'd*:—
            identity 256
            injury, extent of 254
            literature, natural enemies, remedies 258
    English, Japanese 243
    Persian 253, 254
    weevil or curculio 213, 240
        bibliography 253
        control methods 248
        description 246
        distribution, North America 249
        food plants of 247
        injury and abundance 243
        life history and habits 245
        previous knowledge 241
Weevil: walnut, white pine 213
Wheat and corn cob feed 305, 330
    bran 300, 318
    feed 301, 322
    middlings 300, 320
White grubs 215, 288, 289
        control methods 290
    marked tussock moth caterpillars 216
Wilcox Fertilizer Co.:—
    Wilcox Complete Bone Superphosphate 80
        Corn Special 80
        Fish & Potash 80
        4-8-10 Fertilizer 80
        Grass Fertilizer 80
        High Grade Fish & Potash 80
                Tobacco Special 80
        Potato Fertilizer 80
            Onion & Vegetable Phosphate 82
        Special Superphosphate 82
        Dry Ground Acidulated Fish 37
                Fish Guano 37
                Steamed Bone 42
        High Grade Tankage 38
        Pure Ground Bone 41, 42
        Acid Phosphate 29, 30
        Basic Slag 27, 28
        High Grade Sulphate of Potash 33
        Muriate of Potash 34
        Nitrate of Soda 8, 9
Williams' Pink Pills for Pale People 187
Winthemia quadripustulata 286
Wistaria, crown gall on Chinese 358

PAGE
Wood ashes and substitutes 90
Woodruff, S. D. & Sons:—
    Woodruff's Home Mixture 57, 82
Woolly maple leaf scale 217
Yellow-necked caterpillar 216
Yew, dampening off of 349
Zeuzera pyrina 216

State of Connecticut
PUBLIC DOCUMENT No. 24

Thirty-sixth Annual Report

OF

The Connecticut Agricultural Experiment Station

Being the annual report for the year ending October 31

1912

PRINTED BY ORDER OF THE LEGISLATURE

HARTFORD
PUBLISHED BY THE STATE
1913

PUBLICATION
APPROVED BY
THE BOARD OF CONTROL.

THE TUTTLE, MOREHOUSE & TAYLOR COMPANY

CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

OFFICERS AND STAFF.

SEPTEMBER 30, 1912

BOARD OF CONTROL.

His Excellency, SIMEON E. BALDWIN, *ex officio, President.*	
PROF. H. W. CONN, *Vice President*	Middletown
GEORGE A. HOPSON, *Secretary*	Wallingford
E. H. JENKINS, *Director and Treasurer*	New Haven
JOSEPH W. ALSOP	Avon
WILSON H. LEE	Orange
FRANK H. STADTMUELLER	Elmwood
JAMES H. WEBB	Hamden

STATION STAFF.

ADMINISTRATION.	E. H. JENKINS, PH.D., *Director and Treasurer.* MISS V. E. COLE, *Librarian and Stenographer.* MISS L. M. BRAUTLECHT, *Bookkeeper and Stenographer.*
CHEMISTRY.	
ANALYTICAL LABORATORY.	JOHN PHILLIPS STREET, M.S., *Chemist in Charge.* E. MONROE BAILEY, PH.D., C. B. MORISON, B.S., R. B. ROE, A.B., C. E. SHEPARD, *Assistants.* HUGO LANGE, *Laboratory Helper.* V. L. CHURCHILL, *Sampling Agent.*
PROTEID RESEARCH.	T. B. OSBORNE, PH.D., *Chemist in Charge.* MISS E. L. FERRY, A.B., *Assistant.* MISS LUVA FRANCIS, *Stenographer.*
BOTANY.	G. P. CLINTON, S.D., *Botanist.* E. M. STODDARD, B.S., *Assistant.* MISS M. H. JAGGER, *Seed Analyst.* MISS E. B. WHITTLESEY, *Herbarium Assistant.*
ENTOMOLOGY.	W. E. BRITTON, PH.D., *Entomologist; also State Entomologist.* B. H. WALDEN, B.AGR., D. J. CAFFREY, B.S., H. B. KIRK, *Assistants.* MISS F. M. VALENTINE, *Stenographer.*
FORESTRY.	SAMUEL N. SPRING, M.F., *Forester; also State Forester and State Forest Fire Warden.* W. O. FILLEY, *Assistant; also Asst. State Forester.* MISS E. L. AVERY, *Stenographer.*
PLANT BREEDING.	H. K. HAYES, M.S., *Plant Breeder.* C. D. HUBBELL, *Assistant.*
BUILDINGS AND GROUNDS.	WILLIAM VEITCH, *In Charge.*

TABLE OF CONTENTS.

	PAGE
Officers and Staff	iii
Contents	v
Report of Board of Control	ix
Report of Treasurer	xvii
Errata	xx
Report on Commercial Fertilizers	1
Observance of the Fertilizer Law	1
Sampling and Collection of Fertilizers	1
Explanations concerning Analyses and Valuations	3
Analyses of Materials chiefly valuable for Nitrogen	8
Phosphoric Acid	25
Potash	31
Nit. and Phos. Acid	36
Cost of Plant Food in Raw Materials	44
Analyses of Mixed Commercial Fertilizers	46
Home Mixtures	84
Miscellaneous Fertilizers	86
Report on Food Products	95
Canned Corn	96
Dried Fruits	97
Gluten and Special Foods	107
Honey	110
Rice	118
Sausage	122
Canned Tomatoes	125
Net Weight of Package Goods	137
Report on Drugs	146
Acetic Acid	146
Aconite	148
Asafetida	150
Syrup of Figs	153
Glycerine	157
Heroin	158
Magnesium Carbonate	159
Magnesium Citrate	160
Opium	166
Paregoric	166
Sodium Salicylate	169
Precipitated Sulphur	170
Turpentine	172
Proprietary Remedies	184

PAGE
Report on Drugs, *cont'd.*
Food and Drug Products examined for Dairy Commissioner 201
Miscellaneous Products 205
Summary 208
Report of the State Entomologist 209
Inspection of Nurseries 217
Inspection of Imported Nursery Stock 220
Inspection of Apiaries 223
Gypsy Moth Control Work 224
Brown-tail Moth Control Work 229
A new Sawfly Pest of Blackberry 236
The Walnut Weevil or Curculio 240
The Walnut Bud-moth 253
The Mosquito Plague and How to Control it 259
The Fall Armyworm 284
Serious Injury by White Grubs 288
Miscellaneous Insect Notes 291
Report on Commercial Feeding Stuffs 297
Law regarding Feeding Stuffs 297
Oil Seed Products 298
Wheat Products 300
Maize Products 301
Rye, Buckwheat, Oats and Barley Products 303
Miscellaneous Feeds 304
Digestibility of Feeding Stuffs 309
Average Composition of Feeds 310
Manurial Ingredients of Feeds 313
Cost of Feeds 316
Analyses of Feeds 318
Feed Definitions 338
Report of the Botanist 341
Notes on Plant Diseases 1911 and 1912 341
Chestnut Bark Disease 359
Historical Consideration 359
Characteristics of the Disease 364
Distribution and Hosts 370
Damage and Loss Caused 378
Present Situation and Prospects 380
Relation to Condition of Host 389
Previous Chestnut Troubles 407
Native Home of the Fungus 413
American Species of Endothia 417
Artificial Cultures 428
Inoculation Experiments 434
Preventive Experiments 442
Recommendations for Connecticut 447

PAGE

Report of the Botanist, *cont'd.*

Chestnut Bark:

Literature 449
General Summary 452
Report of State Forester 455
Forest Fires 457
State Forests 462
The Station Forester 466
Rainbow Forest Plantations 471
Forest Planting in Connecticut 485
Index 509

REPORT OF THE BOARD OF CONTROL

OF

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

To His Excellency, Simeon E. Baldwin, Governor of Connecticut:

The Board of Control of The Connecticut Agricultural Experiment Station herewith respectfully submits its report for the year ending November 1, 1912.

The following changes in the Station staff have occurred:

Samuel N. Spring, B.A., M.F., who has served the State and Station most efficiently as their forester for three years, resigned on October 1, 1912, to accept a professorship in Cornell University.

Mr. W. O. Filley, the assistant forester, has been appointed to fill this vacancy in our staff, and Mr. A. E. Moss, M.F., a graduate of The Connecticut Agricultural College and of the Yale Forest School and later a forestry assistant of the United States Forest Service, has been appointed assistant Station forester.

R. B. Roe, B.A., who has served as an assistant chemist for three and one-half years, resigned in October to accept a position in a chemical research laboratory.

Harry B. Kirk, formerly for two years assistant in economic zoölogy in the Pennsylvania Department of Agriculture, was appointed an assistant in the Entomological Department in February, 1912.

An exhibit illustrative of the work of the several departments of the Station was made at three of the agricultural fairs during the fall, with members of the staff in attendance to explain it and answer questions. While such exhibits have seriously interrupted the Station work, they have proved to be most effective in bringing its results immediately and in a striking way to those who should get practical benefit from them.

The same purpose is also served by frequent addresses before granges, farm institutes, field meetings, etc. During the year ninety addresses of this sort have been made by members of the staff in response to requests.

While the attendance of the Station staff at fairs, farm institutes and other meetings has been necessary and profitable, it has taken much time which was greatly needed for its experimental study and work, which are the Station's special sphere.

The rapid development of the so-called agricultural extension, in which the national government is expected to coöperate with the agricultural colleges, should reduce the necessity for these outside activities on our part. The greatest efficiency of the Station can only be secured by the uninterrupted course of its special work. On the other hand, the extension of agricultural teaching and demonstration by new agencies abundantly provided with funds but not so amply supplied with trained teachers puts an added responsibility on both College and Station to do thoroughly and with the least possible interruption the sound teaching and painstaking research on which the whole agricultural extension effort must rest, if it is not to prove an injury rather than a blessing.

The valuable Station library, now numbering about 8,000 volumes, had until this year no suitable place for orderly arrangement and easy reference. The quarters formerly used for a chemical laboratory have recently been equipped with steel shelving, electric lights and other necessary furnishings, and the general consulting library with the various card catalogues has been installed in it, under the direction of Miss Cole, the librarian.

The Report of the Station staff, which is printed with this report of its Board of Control, makes unnecessary any detailed statement of what has been done. The Report itself describes only that part of the work which is of present importance to farmers, but besides this there have been printed in scientific journals eighteen papers giving the results of Station investigations.

The following incomplete summary will show the scope of the Station's work:

CHEMICAL DEPARTMENT.

Seven hundred and eighty samples of fertilizers and manures and 273 of feeding stuffs have been analyzed and the results published. Twelve hundred and fifty samples of human food products and 395 samples of drugs have been examined, the results published, adulterated samples reported to the Dairy and Food Commissioner, and evidence furnished in court trials in eighteen cases.

Over 2,000 samples of food products have been weighed or measured as a basis for establishing regulations on the subject, as required by an Act of the last General Assembly.

An improved method of determining starch in meat products has been devised and much coöperative work done for the Association of Official Agricultural Chemists.

BOTANICAL DEPARTMENT.

The orchard experiment at Yalesville (now in its fourth year) on a block of 900 trees is planned to determine the effect of fertilizers on growth, yield, winter injury, occurrence of yellows, and bearing life of the trees.

The effects of different sprays on peaches, apples and other fruits have been carefully tested.

Studies of muskmelons—with reference to varieties, spraying and disease resistance,—of the calico of tobacco, of peach yellows, and extensive experiments and study of the nature and spread of the chestnut blight are also in progress.

Seeds sent by seedsmen and farmers, and some samples bought by the Station have been tested as to vitality and, where necessary, as to purity, to the number of 863.

ENTOMOLOGICAL DEPARTMENT.

This department has determined the life histories of three little-known and destructive insects and the means for combating them.

Studies on the white pine weevil are not yet concluded.

It has coöperated by furnishing inspection, information and advice to organizations and individuals who have engaged in mosquito control work.

It has inspected the 54 nurseries of the State, covering some 770 acres; 30 orchards and gardens; 987 packages of imported nursery stock; and 153 apiaries containing 1431 colonies.

The gypsy moth has been so nearly exterminated at Stonington that very careful search fails to discover a single specimen, and at Wallingford very few specimens have been found. These two very threatening invasions have thus been stamped out.

The brown-tail moth work in the northeastern part of the State has shown a great diminution of the pest where work was done last year, but a gradual spread of the invasion. This work could and should be done by local authorities and not left for the State.

FORESTRY DEPARTMENT.

About 528,000 forest seedlings have been supplied at cost to owners of Connecticut forest land for planting, and about 290,000 are ready for sale in 1913.

The Station's experimental forests at Rainbow and Enfield have needed little except fire protection.

About 76,000 seedlings have been set in the State Forests. One lot of twenty acres badly infected with chestnut disease has been cut clean and is to be set to pine in 1913. No fire has occurred on either of these tracts.

An accurate type and stock map of the Portland Forest has been made, with a plan for the permanent management of the forest.

The number of spring fires, 254, and the estimated damage, $21,700, have been much less than in the previous year, owing partly to the plentiful rain and partly to increased efficiency of the fire warden service. During the danger season two lookout stations and fire patrols of certain railroad lines—services which were paid for chiefly by a United States government appropriation—greatly helped in promptly discovering and extinguishing forest fires.

Twenty-seven examinations of forest tracts ranging in size from 10 to 500 acres were made for and at the request of the owners and advice given as to their treatment.

A full report has been made on the woodworking industries of the State in coöperation with the United States Forest Service and will soon be published.

The State forester was made a member of the Commission on the Taxation of Forest Land, and the field work necessary to secure information on the matter was put in his charge. This has required a very careful and laborious study of forest conditions, the results of which will appear in the Commission's report.

PLANT BREEDING.

(Supported by Adams Fund.)

Mr. Hayes has continued the study of tobacco, to determine precisely how different measurable characters of the plant—such as size, shape and number of leaves, height of plants, etc.—are inherited by crosses or hybrid plants, and to discover any fixed relation that there may be between these and the subtile characters which make "quality." The practical purpose is to find a way in which improved strains of tobacco may be produced. Many thousand measurements of single plants have been made for this study, and 35 row selections of 250 plants each have been separately harvested, cured and fermented and are immediately to be sorted and judged as to quality by experts. The commercial side of this work is in coöperation with the United States Department of Agriculture.

Further tests of the merits of using for seed first generation hybrids of corn have been made at the experiment field, as also a study of the effects of crossbreeding and inbreeding of tomatoes. Other work has been on selections of rye, testing the value of selection in forest seeding, and on developing an improved variety of muskmelon.

PROTEIN RESEARCH.

(Supported by Adams Fund.)

This department, being devoted wholly to technical research, is supported by the Adams Fund, which, according to Act of Congress, must be spent wholly for such work.

The nutritive effect of the separate proteins or flesh-forming materials of food has been the main object of study this year and has yielded very valuable results.

The Station correspondence has involved the writing of 11,922 letters and manuscript reports. (Main office 5,357, chemical department 623, botanical 507, entomological 2,823, forestry 2,107, plant breeding 200, protein research 305.)

During the year there have been issued a report of 445 pages with 32 plates in an edition of 10,000 copies, and four bulletins aggregating 77 pages with 12 plates in editions of 9,500.

A technical bulletin of 45 pages with 5 plates was issued in an edition of 2,000 copies.

We wish again to call attention to the pressing needs of the Station. In 1895 the General Assembly appropriated $10,000 to the Station as an annual payment for its support, and the same amount has been paid yearly ever since. But in the meantime it has, by various Acts, greatly increased the amount of work required of the Station without in any case providing additional funds to meet these requirements, nor was this work of a kind which could be paid from funds appropriated by the national government. Thus:

In 1899 the Assembly passed a law regulating the sale of cattle feeds, requiring the Station to collect samples and make and publish analyses of the different brands yearly, but with no appropriation for the work.

In 1901 the law regarding insect pests was passed, appropriating to this Station $3,000 for the use of the State Entomologist in executing the law, creating the office of State Entomologist but providing that he shall receive no salary other than that which he received as a member of the Station staff, i. e., his salary was to be paid from Station funds.

At the same session the office of State Forester was created and with the same provision as to payment of his salary.

An Act of this session also required that all apparatus used in determining fat in dairy products as a basis of payment should be tested and marked by this Station or by the Agricultural College, but no appropriation was made for it. All this work, not very large in any one year, has been done without charge at this Station.

In 1903 a law was passed regarding renovated butter, which placed further work on this Station.

In 1907 the Assembly passed a bill much more elaborate than previous ones on the same subject, to prevent the sale of adulterated, misbranded or poisonous foods, drugs and liquors. It only repealed those parts of existing statutes which were inconsistent with it. This law, with the increased public attention which has been drawn to the subject and with the extension of the work to cover drugs and liquors, has greatly increased the work required of the Station with no addition to its means of meeting the demands.

The General Assembly recognized the increased work involved by increases in the salaries of the Dairy and Food Commissioner and his deputy commissioner and in provision for the expenses of their office, but made no further provision for the chemical work involved.

The Assembly in 1911 passed an Act concerning Adulteration of Turpentine, which is to be enforced by the Dairy and Food Commissioner and the Director of this Station "acting jointly." About 150 samples of turpentine have already been examined, of which 30 were adulterated.

The same session of the General Assembly passed an Act requiring a statement of the net quantity of contents to be marked on all food products in packages, and providing that the Dairy and Food Commissioner and the Director of this Station shall establish rules regarding allowances to be made for variations from the alleged net weight of such packages. There are no published data on the subject and we are therefore making an extensive series of weighings of certain package goods and containers to determine the present range of net weights in the market. The Dairy and Food Commissioner buys what goods are required; the Station does the work.

In no one of the cases cited above has any appropriation been made to the Station to cover the cost of the work.

The result has been that the Station, at the sacrifice of agricultural experiment and research work which is its proper function, has been forced to do this control work and to use for it funds which should rather have been devoted to the object for which this Station was established: namely, agricultural investigation and experiment.

At the same time, the proper demands made on the Station for assistance in all branches of farming have greatly increased. It is no longer possible for the Station to meet all these. Its income can no longer meet its expenses and unless it is more adequately supported it will be necessary to curtail its present field of work, making it rather a control station than an agricultural experiment station. The call for sound research in the interest of practical agriculture was never so pressing as it is now. It surely is not the time to force this, the first established Station in the country, to curtail its experimental work.

The above statement of the facts and present situation requires no argument to show the reasonableness of the request of this Board that the General Assembly will increase the annual Station appropriation by $7,500, which by careful estimate is the amount which must be yearly spent in the control work above mentioned for which the State has never made appropriation, and the appropriation for insect pest work by $1,000.

All of which is respectively submitted.

GEORGE A. HOPSON, *Secretary.*

REPORT OF THE TREASURER, 1912.

E. H. Jenkins, in account with The Connecticut Agricultural Experiment Station for the fiscal year ending September 30, 1912.

Receipts.

Balance on hand, October 1, 1911 (Analysis Fees)		$ 52.60
State Appropriation, Agriculture	$10,000.00	
State Appropriation, Food	2,500.00	
State Appropriation, Insect Pest	3,000.00	
State Appropriation, Gypsy Moth	2,500.00	
United States Appropriation, Hatch	7,500.00	
United States Appropriation, Adams	7,500.00	
Analysis Fees	5,500.00	
Sale of Mt. Carmel Farm to Lockwood Trust	6,000.00	
Sale of Farm Products	386.99	
Miscellaneous Receipts	75.61	
From the Lockwood Income	11,046.13	
		56,008.73
Total		$56,061.33

Disbursements.

E. H. Jenkins, director, salary	$2,800.00
E. H. Jenkins, treasurer, salary	400.00
G. A. Hopson, salary	100.00
V. E. Cole, "	850.00
L. M. Brautlecht, "	750.00
J. P. Street, "	2,500.00
T. B. Osborne, "	2,400.00
E. M. Bailey, "	1,550.00
C. B. Morison, "	1,200.00
R. B. Roe, "	1,125.00
C. E. Shepard, "	900.00
W. E. Britton, "	2,000.00
G. P. Clinton, "	2,200.00
E. M. Stoddard, "	900.00
S. N. Spring, "	2,500.00
W. O. Filley "	1,500.00
H. K. Hayes, "	1,500.00
Edna L. Ferry, "	1,008.34
H. Lange, "	925.00
V. L. Churchill, "	825.00

Wm. Veitch, salary		$ 675.00	
E. L. Avery, "		480.00	
H. W. Kiley (Labor)		728.00	
Wm. Pokrob "		728.00	
C. D. Hubbell "		728.00	
Geo. Graham "		728.00	
M. H. Jagger "		520.00	
Labor		3,746.46	
Publications		676.18	
Postage		205.81	
Stationery		423.52	
Telephone and Telegraph		162.53	
Freight and Express		285.49	
Gas, Kerosene and Electricity		748.11	
Coal		1,625.70	
Water		148.88	
Chemicals and Laboratory Supplies		1,205.18	
Agricultural and Horticultural Supplies		232.13	
Miscellaneous Supplies		574.69	
Fertilizers		386.61	
Feeding Stuffs		372.27	
Library and Periodicals		750.77	
Tools and Machinery		464.17	
Furniture and Fixtures		1,184.67	
Scientific Apparatus		166.31	
Live Stock		200.00	
Traveling by the Board		106.61	
Traveling by the Staff		1,144.31	
Traveling in connection with Adams Fund Investigations		98.11	
Fertilizer Sampling		233.64	
Food Sampling		183.34	
Insurance		140.00	
Insect Pest Appropriation to State Entomologist		3,000.00	
Contingent		186.50	
Lockwood Expenses		400.00	
Gypsy Moth Appropriation to State Entomologist		2,500.00	
New Buildings		58.00	
Betterments		389.89	
Repairs		328.27	
Rental of Land		160.00	
			$55,008.49
Balance on hand, October 1, 1912:			
Analysis Fees	$755.17		
State Agricultural Appropriation	297.67		
			1,052.84
Total			$56,061.33

New Haven, Oct. 31st, 1912.

This is to Certify that we have examined the accounts of E. H. Jenkins, Treasurer of The Connecticut Agricultural Experiment Station, for the year ending Sept. 30, 1912, have compared the same with the vouchers therefor and found them correct.

William P. Bailey,
Edward S. Roberts,
Auditors of Public Accounts.

ERRATA.

Page 12. It is stated that the Humphreys, Godwin Co. has made a rebate to buyers when the cotton seed meal sold by it was found to contain less nitrogen than was guaranteed. It might be inferred from this statement that the other firms there named had not done this, but we have since been advised that the Apothecaries Hall Co., of Waterbury, and W. Newton Smith, of Baltimore, have also given similar rebates.

Page 92. The guaranteed percentage of phosphoric acid in Wizard Brand Manure, sold by the Pulverized Manure Co., Chicago, analysis number 377, is incorrectly stated as four.

The statement that this brand contains much less phosphoric acid than is guaranteed is also incorrect.

One per cent. of phosphoric acid is guaranteed and this guaranty is fully met.

Page 362, line 4 from bottom, read Moravian instead of Bavarian.

Manufactured by
GAYLORD BROS. Inc.
Syracuse, N. Y.
Stockton, Calif.

M710104
SD12
C6
no.8
Forestry